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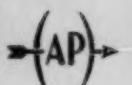
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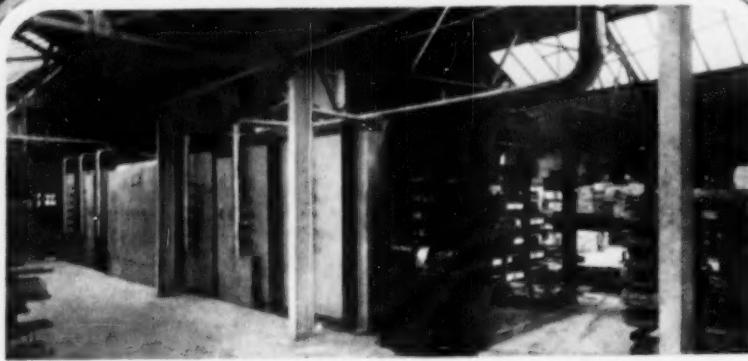
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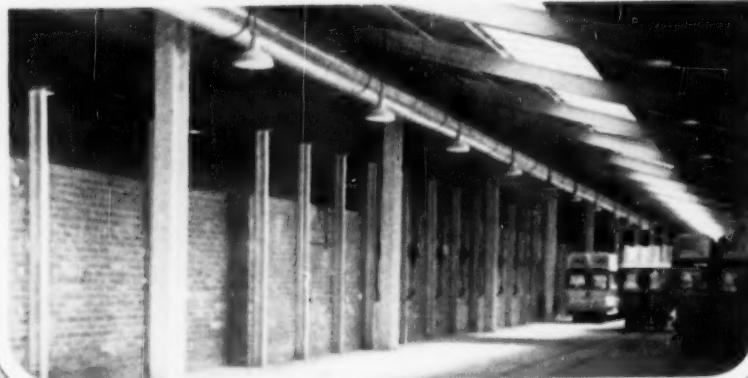
Ceramics

"WHITEHALL WONDERS"

THIS is not a box office hit! Yet the scene in the coffee shop was amusingly distracting.

"People are never satisfied" said the Railway Man. "They ask for a profit and we increase our revenue in 2 years by a cool 10 per cent. and make 10 per cent. less journeys! Of course we must increase fares. What do these people think we are?"

Clarence, the Board of Trade Man, stretched his legs. "I know, most disheartening. Didn't we close the dollar gap? And now they are complaining about the shortage of coal!"

The Man in the Street was outstanding. "Dollar gap my foot! Iron and steel doubled its exports in 2 years. So did machinery—and motor vehicles. Textiles was three up! and mind you—you folks did not run those industries.

"We have 25 per cent. less pigs in Britain than 1939—and we are buying frozen foreign pork chops at 7s. a lb.!

"You mechanise the pits more and more and get less and less clean coal! Why don't you clean it? I'll tell you! If you did the output figures would look stupid.

"You've got an industry like steel going great guns—no strikes, good output and you want to put it in charge of a scrap metal merchant."

Mr. Man in the Street stumped out of the coffee shop and Clarence nonchalantly strolled over to the telephone. "I'll fix him" he said.

"M.I.5." he asked questioningly. "Oh Harry? there's a chap called Man in the Street. Drag him in! A filthy Commo—anyway most seditious. These chaps outside must learn that we are the masters now!"

COMMENT

by ARGUS

IN December 1 drew attention to complaints of the American Vitreous China Association as to unfair competition from an American sponsored factory in Puerto Rico where the wage rate is one-third of the American. But unfairness does not end there.

It is well known that after the turn of the century Japan had built up her pottery industry until it held about 37 per cent. of the world trade compared with 32 per cent. in Britain and 18 per cent. in Germany. These were 1937 figures.

Copying British Ware

Now come further examples of blatant Japanese copying of British decorated ware. Among the famous articles quoted are the Beatrix Potter figures in which not only is the copyright infringed but the Japanese imitations are being sold in America below the cost of production in Britain. Wedgwood figures and imitations of ware made by Paragon China, Price Bros. and J. H. Wetherby are mentioned. Another case is the Mabel Lucie Attwell figures by Shelley Potteries.

Representations have been made previously to General MacArthur's Headquarters—so far without tangible result.

Relative Price

Some idea of the type of competition faced is the Beatrix Potter ware sold in America for 3s. 7d. as against the British product for 2 guineas. The Japanese wholesale price at 4½d. each is nearly five times less than the actual cost in wages of making each figure in the Longton Pottery.

There is no suggestion that the Japanese product is a quality product. Various opinions have described them as crude copies which were badly made from a poor body and decorated in the cheapest manner.

It appears that someone in America has undoubtedly sent the articles to Japan where plastic moulds have been made.

Some time ago Mr. Bottomley, Secretary for Overseas Trade said that if such action took place and it was brought to the Government's notice, the Ministry of Trade and Industry in Japan would put on an export control.

It looks as though someone somewhere is taking a long time to stop something, but it is a serious state of affairs for Britain.

America and Culture

In pottery, as has been said before, one reaches the alliance of the craftsman and the artist— between them they create beauty, and rightly the product goes to a restricted market at a relatively high price—high because it is not the work of a machine but is the artistic creation of the artist and the potter. If there is no protection to the design and crude flamboyant copies crowd the market, it is an attack not only upon the individual concerned but on the protection or copyright of a man's cultural work. America has boasted an emphasis upon culture — she has imported musicians, artists, Old Masters, old violins, and in fact a vast stock of the products of contemporary and old European cultures.

By permitting this state of affairs to exist, she is failing to realise the importance of a great nation—she is

the home of private enterprise and individual initiative, but if she penalises the artist and the craftsman and allows wholesale pilfering of their brain-children, it is striking a deadly blow at the realistic principles of a democratic civilisation.

Only America can act, and those dealers in America who are handling this Japanese junk must be stopped—it not only affects Britain but it does not help the American pottery industry itself.

A Return Favour

The Board of Trade has been quick to seize upon pottery as a hard currency earner. The British pottery industry has boosted its exports from 5,000,000 cwt., worth £19,000,000 in 1948, to nearly 6,000,000 cwt. worth £22,000,000 in 1950. In exports to the United States, the figures were £800,000 in 1949 but £1,300,000 in 1950. For these respective years they were £1,400,000 and £2,000,000 to Canada. The 1950 earthenware exports to America showed a jump of from £900,000 to £1,200,000 and the market was retained in Canada during the 2 years in question.

The pottery industry has helped the Board of Trade and His Majesty's Government in closing the dollar gap. As a *quid pro quo* it is not unreasonable to ask a return favour for really active steps to be taken to protect the British Pottery industry from an extremely menacing situation. Some have called General MacArthur "The Japanese Mikado" — others compared him with "Cæsar" and "Alexander the Great." If these are not figurehead descriptions could he not spare some effort in protecting the pottery industries of both his own country and that of his ally?

Widen the Gap

Not everyone agrees with this. An excuse is found because copying takes place the world over. The point is that in Britain opportunities exist for the owner of a patent or a copyright to protect himself, but pre-war, one or two British Manufacturers tried it on in Japan—it cost them the earth! Now we have the Japs where they put themselves and there is no need to stand for their little tricks if the Americans will take the step of a Conqueror

One of our contemporaries issued the following platitude. "The only way to ward off the threat of Japanese competition is to widen the gap in quality between the products of North Staffordshire and Nagasaki—and to keep on widening it." But surely the gap is wide now! And the potters of North Staffordshire are rightly complaining.

A Teacher's Salary

But in turning to this question of quality I saw a vacancy advertised in this same contemporary for "A full time teacher with high qualifications in pottery." Salary—£300 a year! Mind you if the teacher has a degree he gets a little extra. But if he is a trained potter with a flair for teaching he gets less than a science graduate with a nodding acquaintance with pottery. But for £6 a week what do they expect? And what can the pottery industry expect from his or her pupils? This is surely one way to widen the quality gap between North Staffordshire and Nagasaki in the wrong direction!

Life becomes increasingly difficult for the potter. The 1st of January saw him landed with an excessive increase in electricity. Now he faces not only an increase in the price of coal but a 15 per cent. reduction in supply. Firms both large and small have already been working from hand to mouth, and it looks as though the Whitehall phrase "bottle-neck" is going to have severe repercussions upon the more colloquial "bottle-neck" of the potter or what he has replaced it with.

Pottery Managers' Manifesto

In another part of this issue has been published in full a manifesto issued by the British Pottery Managers' and Officials' Association in which it outlines simply and succinctly the aims and objects of the society. Firstly, they should be offered congratulations. The Manufacturers' Federation and the Workers' Society have hit the headlines on more than one occasion, but with the typically middle-class tendency to "say nowt" the Pottery Managers have not aired their views.

The Editor of CERAMICS in his recent address to the Pottery Managers' Association pointed out that it is the Pottery Managers who maybe work *for* the manufacturer but *with* the men, so that they have day-by-day to effect a liaison between the discussion in the board room and the problems on the factory floor. There is no excuse indeed for their exclusion from any equivalent to a Development Council. Certainly they have an equal right with both the Federation and the Society, and indeed the sense of balance which they can introduce into all discussions is an invaluable prop to any such scheme of co-ordination.

The Question of Management

It is interesting indeed that they should tackle the question of management. As they say "The opportunity should be given to workers at the bench of attaining managerial status." Too frequently this is the cry of the T.U.C. without due consideration. Of course, as the manifesto says, Management is a "specialised job" and additional training and practical knowledge is essential. It is here that the T.U.C. falls down. Having shouted the odds for promotion from the bench, they have done nothing, nor indeed are they doing anything, to ensure that training facilities for the future technologist of the industry are imple-

mented. I see a possible reason here! If a large number of Trade Unionists were trained in management they would quickly see through utterances of their platform union fire-eaters, who have not! I think it was Lord Acton, the Tory, who commented on the 19th Century Education Act with the statement "We are educating our future masters." The T.U.C. hierarchy are not risking that! Strange how politicians change little with the centuries and how all of them, once in office, become reactionary!

The Problem

At the North Staffordshire Technical College there exist training facilities, but that progressive institution which has pioneered the way towards a more broad technical training could receive greater assistance both from His Majesty's Government and from the manufacturers themselves. Maybe expediency is a short term policy, but the problem which exists is the immediate one of better training facilities in the industry. At this stage, therefore, the claims for finance for training in management outweigh the claims for more fundamental research as such! CERAMICS has much pleasure in sponsoring the cause of the Pottery Manager. His strength lies in the fact that he is responsible day-by-day for production. And it is production which pays for both training and research as well as administration from Transport House or Federation House!

Potterton Gas Division.—Mr. H. E. Poyser has been appointed to the new post of general manager of the Potterton Gas Division of Thomas De La Rue and Co. Ltd. He was previously sales manager of the Division. Mr. Ernest Brooks (works manager) has succeeded Mr. Poyser as sales manager and Mr. J. R. Knott (sales manager, Midlands area) has been appointed divisional works manager. Mr. J. E. Cooper, formerly technical manager, is now research and development manager of the Division.

LUSTRES

Their Origin and Use Today

THE origin of the art of producing lustres on pottery and faience is uncertain, but it is probable that it may be attributed to the Arabs. The earliest examples known are considered to date from the 9th Century. The Persians have also left remarkable pieces of lustred ware but these show all the characteristics of Arabian art. The same applies to pieces found in Egypt and Syria, and point to the fact that the Arabs probably carried the secrets to those countries which they conquered. It was only at the beginning of the 15th Century that the art was developed to any considerable extent when the Moors set up potteries at Malaga in Spain, and exported golden lustred ware (*oevres darées*) to all parts of the then-known world.

This industry prospered till the end of the 15th Century, when Ferdinand the Fifth, King of Aragon, liberated Spain from the Moors, and when, in 1610, King Philip III banished all Moors from the country, the industry practically disappeared with the exception of a few potters who carried on the art, handing down the secrets from generation to generation.

Italian Lustred Ware

In the 15th Century the Italians attempted to manufacture Arab lustres, but for many years their attempts were fruitless until Galgano di Belforte, a Sienna potter, went to Valencia and acquired the secrets of the art. The Italians then developed the process, and made lustred majolica ware which reached a very high level of excellence.

Potteries were also established in France, notably at Poitiers, in the 14th Century, where, with the aid of a Moorish potter, lustred ware was produced.

After this time the production of lustred ware, which was never an easy process, seems to have declined and only to have been revived around 1860.

Early Description of the Process

There are no writings dealing with the original lustres made in the East, but documents are available dealing with the mixtures and processes of the Italian and Moorish potters in the Middle Ages. There is, for example, in the Victoria and Albert Museum at South Kensington, a manuscript of C. Piccolpassi dated 1548 which describes the process as practised by the Italian potters of that time.

The ancient recipes of the Moors in Spain were also published in 1877 (J. F. Riano: "Sobre la manera de fabricar la antigua loza dorado de Manises." Madrid, 1877).

Briefly the method described is the one in use today for producing the so-called Arabian or smoked lustres. The glazed ware was covered with a paste made from clay containing a reducible metal compound of, say, silver or copper, and mixed with vinegar. After drying, the coated ware was fired to dull red heat, and reduced by exposing it to wood smoke. On

cooling it was well washed to remove the clay, and then the lustred surface was seen.

Revival of Lustred Ware in Modern Times

According to the late Mr. William Burton, the actual revival of lustring in modern times is due to an apothecary of Gubbio, called Carocci, about the year 1860. Workmen who had been employed

red clay formerly used in the Middle Ages, and also that firing was done in a muffle oven instead of letting the flames impinge on the ware as in former times. Some very fine copper-red lustres were produced and this work, together with that of other English potters, effectively revived interest in this type of lustred ware.

From the old manuscripts the formulæ for the pastes applied to the

In-glaze lustred ware produced by reduction

by him went to various other factories in Italy and France carrying their knowledge with them, and about 1870 one appeared in Staffordshire. He, however, failed to produce any saleable ware and soon afterwards left the district. About that time William de Morgan worked out the process quite independently, and later other potters made lustred ware with the aid of workmen formerly employed by him.

Mr. de Morgan's process was essentially that described above, except that china clay replaced the

wares prior to reduction were as follows:

	Arabian		Italian
Red ochre	71·98	66·67	49·49
Silver sulphide	1·15	—	1·03
Copper sulphide	26·87	33·33	24·74
Mercury sulphide	—	—	24·74

Investigations of M. L. Franchet

M. L. Franchet (*Annales de Chimie et de Physique* [8] 9, 1906, "Etude sur les Dépots Métalliques obtenus sur les Emaux et sur les verres (Lustres et Reflets Métalliques)") carried out a long series

of experiments with various mixtures containing copper, silver and bismuth compounds, and succeeded in obtaining, in addition to the yellow and red lustres, a series with blue colours when bismuth was added. In particular he made up the following mixtures:

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Copper carbonate ...	...	30	28	—	—	—	95	—	—
Silver carbonate ...	...	—	2	3	—	—	5	—	—
Bismuth sub nitrate	...	—	—	12	10	—	—	—	17
Copper oxalate	...	—	—	—	5	—	—	—	—
Copper sulphide ...	...	—	—	—	—	20	—	—	2
Tin oxide ...	...	—	—	—	—	25	—	—	—
Silver sulphide ...	...	—	—	—	—	—	—	5	1
Red ochre ...	...	70	70	85	84	55	—	95	80

These were applied to glazes maturing at about 990° C., heated to 650° C. and reduced. Mixtures (1), (2) and (5) give iridescences similar to those on the Moorish and Italian lustres. Nos. (3), (4) and (8) gave bluish deposits, somewhat greenish with No. (3), or a mixture of blue and green with (4) and (8). No. (7) gave brilliant tones of pale yellow, gold and brown, and No. (6) a whitish yellow.

Particular Metal Compound Not Important

From this work it appears to be unimportant which compound of a particular metal is used. Thus copper carbonate, oxalate and sulphide work equally well, and later work has shown that the oxide and sulphate are equally effective.

Similarly considerations apply to the other metals. The use of sulphides in the original formulæ signified the use of the naturally occurring minerals.

Temperature and Time of Reduction Influences Result

The exact effect produced depends to some extent on the temperature of firing and also on the length of reduction. Copper gives first a red colour and then, later, a yellowish metallic lustre.

Many of the old recipes specified broom for producing the reducing smoke, but later workers have shown this to be unnecessary. Sawdust, resin, leather, rubber and camphor work equally well, and most modern workers prefer coal gas.

Modern Pastes

The early potters used vinegar for mixing the clay paste. Nowadays ammonium oxalate solution is preferred. This breaks up on heating giving carbon monoxide which acts as a reducing gas and aids the process. It sometimes happens that the red clay will stick to the glaze after firing, thereby spoiling the piece. This can be avoided by grogging the clay with about 10 per cent. of flint or pitchers. Some workers use only china clay, or even ground pitchers.

In-Glaze Lustres

From the Arabian, or on-glaze lustres, it is only one step to introducing the reducible metal compound into the glaze itself and producing by subsequent reduction an in-glaze lustre. M. L. Franchet (loc. sit.) describes this with a frit melting at 970° C. This was composed of quartz 12, pegmatite 10,500, kaolin 2, sand 20, litharge 30, borax crystals 19,200, boric acid crystals 2, pearl ash 2, salt 1,800. This was ground dry in a cylinder, fritted, cooled and ground.

From this glazes were made up as follows: To 100 parts of frit 10 of kaolin were added, and then small percentages of the metal compound to be reduced, e.g.

	(1a)	(2a)	(3a)	(4a)	(5a)	(6a)
Frit	100	100	100	100	100	100
Kaolin	10	10	10	10	10	10
Zinc oxide	—	1	—	—	—	1
Tin oxide	—	1	—	—	—	4
Silver carbonate	2	½	2	2	—	—
Copper oxide	—	3	—	—	—	—
Bismuth sub nitrate	—	—	4	—	—	—
Copper carbonate	—	—	1	—	—	—
Copper sulphide	—	—	—	2	0 3	1
Silver sulphide	—	—	—	—	2	—

These were applied to the ware using a little gum to help application. After firing up the glaze it was cooled to dull red heat and then reduced. In this way beautiful lustres were produced, and it was possible to follow the changes in colour with reduction time more easily than with the on-glaze lustre previously described.

With glaze (1a) the colour passed from a whitish lustre, through a golden metallic colour, to brown and black colours with diminishing metallic effect, until finally a black, non-metallic colour was obtained.

The second stage gives a brilliant golden colour resembling metallic gold. Glaze 2a gives coppery lustres with bright iridescences due to the presence of silver. No. 3a shows the effect of bismuth, which gives a blue, masking the effects of copper and silver. Combined with (1a) a green metallic deposit is obtained. Glazes (4a), (5a) and (6a) give bright multiple iridescences, the latter often being matte. Any

Hand painted designs in coloured lustres
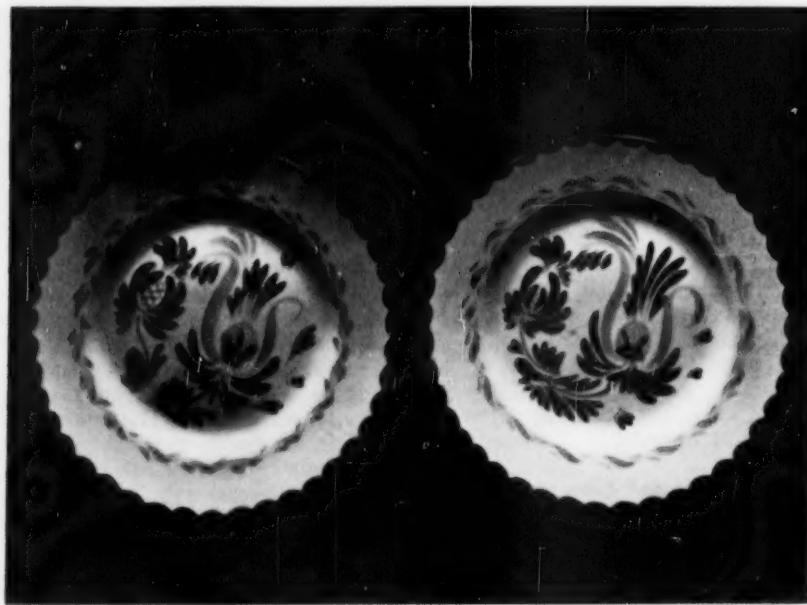
(Courtesy: Johnson, Matthey & Co. Ltd.)

Tea ware decorated with coloured lustres

reducible metal compound of copper, silver, bismuth, etc., can be substituted for those given above.

Lustres in Oxidising Atmospheres

It is also possible to produce lustres in oxidising atmospheres, and this is the only method used to any extent at the present time. The reducing agent is, in this case, incorporated with the metal. Usually the metal is combined with resin to form a resinate, and this is made up into a thick solution with oils like lavender and rosemary oil. On heating to enamel kiln temperatures considerable charring occurs, and the metal compound is reduced to the metal. Where it produces thick, metallic coatings like gold and silver, without iridescence, some workers prefer to call the result not a lustre, but metal plating, reserving the term for those deposits of metals and metal oxides which are thin enough to show iridescent colours by reflected light.

Whatever the merits of this argument, both classes are known by the same name in the trade, and at present lustre ware normally implies ware fired in an oxidising atmosphere using a liquid lustre mixture, sometimes called a Brianchone lustre.

Preparation of Resinates

The resinates are made either by heating a compound of the metal with resin itself, followed by the addition of e.g. lavender oil, or by precipitation of a solution of a soluble metal salt with a solution of resin soap. The latter method is considered to give a more homogeneous product. As an example of the dry method of preparation the following are directions for preparing bismuth lustre:

Ten parts of bismuth nitrate crystals are added slowly to 30 parts of resin melted in a dish. Each addition of nitrate causes frothing, and the mixture is well stirred. When the mass turns brown and the nitrate has all been added, the lavender oil is added in small quantities at a time. Heating

is stopped, the dish covered and the contents left to settle. Finally the clear liquid is decanted off into a shallow dish and exposed to the air till it thickens sufficiently for use.

Precipitation of Resinates

In the wet method the first job is usually to prepare resin soap or sodium resinate. This is done by adding powdered resin to a boiling solution of soda until there is no further frothing and no more resin will dissolve. This indicates that the soda has been completely converted to a solution of sodium resinate. This is then diluted, reboiled and allowed to stand, after which the clear solution is decanted off for use in precipitating resinates. The metal compound, say copper sulphate, is then dissolved in water and the solution of resin soap added, with stirring, until there is no further precipitation of copper resinate. The resinate is then well washed by decantation with water, dried and dissolved in some appropriate oil such as lavender oil, e.g.:

(1) Copper resinate ... 100 parts
    Lavender oil ... 200 ,,
(2) Uranium resinate 100 ,,
    Lavender oil ... 200 ,,
    Benzol ... ... 30 ,,

In this way lustres can be prepared from metals such as iron, uranium, chromium manganese copper, lead, bismuth, zinc and aluminium, and combinations of these can be used to produce some striking colour effects with brilliant iridescences.

Coloured Lustres

Thus, iron gives a red lustre, cadmium a yellowish red, nickel light brown, uranium a greenish yellow, cobalt brownish colours and copper a reddish brown. Mixtures can be used for special effects, thus, bismuth and uranium lustres mixed give a mother of pearl effect, while chromium and lead lustres can be mixed to give a bronze effect.

Full details of these mixtures and of the methods of preparing them will be found in reference books, e.g. "Pottery Decoration," by Rudolph Hainbach (2nd revised English edition, London, 1924). Generally speaking the preparation of liquid lustres is a skilled process and most potters will prefer to buy them ready made from those firms which specialise in the business.

Faults in Liquid Lustres

Brianchome or liquid lustres are liable to peeling if improperly made up, or if applied to dirty ware. They are also subject to bubbling in the kiln if the temperature is too high, and if the oil medium used is too thin. Of the lustres the most durable are the in-glaze, and the least the liquid lustres.

Lustres of Gold and Platinum

The lustres of the noble metals gold and platinum are probably the most widely used in decorating ceramic ware, although, since these are relatively thick deposits held to the ware by fluxes, as has already been pointed out, some authors prefer not to call them lustres at all.

The so-called silver lustres were deposits of platinum on ceramic ware. They are believed to have been first made in this country between 1780 and 1790. According to one authority, a chemist, John Handcock, employed by Josiah Spode, first achieved success in the art, but it was not manufactured at Spode's till 1800. It seems that the pieces made were copies of silver teapots, sugar bowls, etc., which were modelled on the silversmith's designs and, being less expensive than silver, had a ready sale. This state of affairs continued till 1838, when the introduction of electroplating led to its eventual discontinuance.

Liquid Gold

The cheapest form of gold decoration is the so-called liquid gold. This contains 12 per cent. of
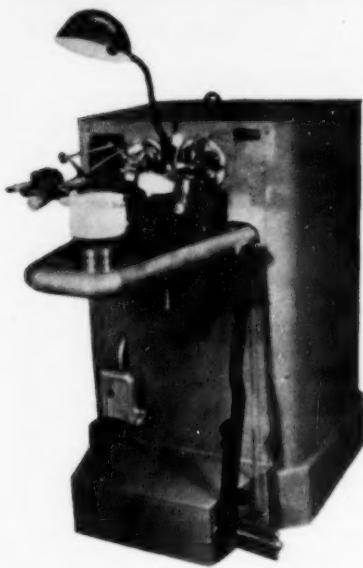
gold in the form of complex gold compounds in essential oils. For cheaper decorations, where resistance to wear is less important, a gold content of down to 7 per cent. can be used.

Preparation of Pure Gold

The chemically pure gold is prepared by dissolving the commercial metal in a mixture of nitric and hydrochloric acids (1 : 3). This solution is diluted and filtered and evaporated to small bulk, when crystals of gold chloride are formed. These are dissolved and recrystallised from water. To precipitate the gold from this substance it is dissolved in water and a solution of ferrous sulphate added until no more gold settles out. This pure gold is a brown powder, which only takes on a metallic sheen when burnished.

The preparation of liquid gold mixtures is a specialised process which is in the hands of a few manufacturers. The usual method of preparation is to dissolve the gold (usually mixed with bismuth and mercury and about 1 per cent. of rhodium) in a liquid known as sulphur balsam. This can be made by dissolving sulphur in a mixture of Venetian and rectified turpentine by warming till a homogeneous liquid is obtained. Alternately turpentine is left open to the air until it has thickened and then it is boiled with sulphur in the preparation of 1 part of sulphur to 5 of the thickened turpentine until all has dissolved. The liquid is then diluted with its own weight of lavender oil. The bismuth is usually added in the form of basic bismuth nitrate and acts as a flux to secure the gold to the ware. Above 600° C. the gold tends to crystallise and give matte effects. The presence of rhodium tends to prevent this.

Smooth Glaze for Bright Gold

Liquid gold gives bright effects when put on a smooth glaze and fired. If the glaze is roughened the brightness is lost and matte effects are obtained. This is sometimes used to produce a pattern in the gold bands. A mixture which will roughen the glaze is applied to the ware with the aid of a transfer and fired. A mixture of pitchers and a flux would be suitable for this. On subsequent gilding the bright gold band will show a matte pattern corresponding to the places where the glaze has been roughened. Another method is to etch the glaze with hydrofluoric acid.

Burnished Gold

Where large areas of gilding are required or where it is desired to put on very thick durable gold bands a gold mixture containing a much higher amount of metallic gold is used.

To prepare this the powdered gold is mixed with the flux, consisting of about 5-10 per cent. of the weight of the gold of basic bismuth nitrate, together with half that weight of borax to soften the flux. This is then mixed with suitable oils and applied to the ware. The bottles of this mixture require thorough shaking before use.

The gold deposits obtained from these solutions are always matte and need burnishing to get the metallic appearance. This is done by rubbing with sand and afterwards flattening the gold particles by rubbing with an agate and a blood stone. For cheaper ware mercury and mercury compounds are sometimes mixed with the gold. These increase the covering power of the mixture, and on firing the mercury vaporises away.

Lemon and Green Gold

The addition of other metals to burnished gold and liquid gold can modify the colour. In the normal way the gold has a reddish tint.

Addition of small amounts of silver turns this to a golden yellow, while larger quantities up to about 50 per cent. gives a greenish gold.

Burnished Silver and Platinum

Silver and platinum can also be applied to ware either in the burnished or liquid forms, in the same way as gold. Basic bismuth nitrate is again used as a flux and for the liquid preparations the metal is dissolved in sulphur balsam as described for gold. Except on electrical porcelain, silver is not widely used nowadays on account of the ease with which it tarnishes in the air, forming silver sulphide. The so-called silver lustres are in fact deposits of bright platinum which is stable in air. Lustre jigs have in recent years regained some of their old popularity.

Gold Dusting Powders

The precious metals are also used in the form of dusting powders for decoration with striking effects. The finely-powdered metal is usually mixed with an equal weight of mercury, for the reasons mentioned above, and the flux is added and the whole well ground. The pattern required is printed on the ware in the usual way using an oil instead of a colour. Usually lamp black is incorporated with the oil to render the printed oil pattern visible. Subsequently the gold powder is dusted on the ware with cotton wool pads. It sticks to the oil and, after cleaning up and firing, produces a pattern in gold. The pads are collected and subsequently sold for recovery of the gold.

Raised Gold Paste

No account of gold decoration would be complete without some reference to that dying craft of decoration by raised gold paste. This is a highly-specialised mode of decoration, used only on the most expensive ware, and a single plate may cost an American as

much as 60 dollars—there are none for the home market! The plate is embossed first by applying the paste, which consists essentially of an opaque white frit. This is modelled to the required design by the decorator and is then painted yellow. Subsequently it is gilded with best gold and fired.

Lustres on Glass

It should be mentioned, finally, that liquid lustres and liquid metal preparations are used nowadays for decorating glass as well as porcelain, earthenware and china.

The method of application is the same, the only essential difference being in the fluxing, since decorated glass is normally fired to lower temperatures than pottery.

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ABRASION TESTER FOR TILES

A PORTABLE device for testing the abrasion resistance of floor surfaces has recently been developed by the American National Bureau of Standards.

The tester consists essentially of a notched steel wheel—an earlier version utilising an abrasive wheel was discarded when it was found that non-uniform abrasion was obtained at the wheel's edge due to clogging and dulling of abrasive grains—mounted on an overhanging frame so that a definite and constant weight will bear upon the specimen as the wheel is turned. The tester was designed to provide for a steady flow of No. 60 artificial corundum between the steel wheel and the specimen which is mounted on an incline; this feature of

steady flow of abrasive grain accounts for the dependability of the method. Though of sturdy design the tester is light enough to be moved easily and set up near the stock pile of tiles. It is composed mainly of wood except for the abrading wheel and its carriage.

In making a test the steel wheel is turned twenty-five revolutions (in approximately one minute), thus cutting a circular segment in the specimen. The length of this segment is measured to a tenth of a millimetre and the segment area computed; this value indicates the abrasive resistance of the material. The correlation coefficient of this laboratory apparatus with actual wear is 0·99 where perfect correlation is 1·00.

Correspondence

SILESTER BONDING PROCESS

DEAR SIR,

In the December issue of CERAMICS there appears an article entitled "The Silester Bonding Process" by Dr. A. E. Williams, Ph.D., F.C.S. describing the use of ethyl silicate as a bonding agent in the production of refractories.

"Silester" is actually the trade name used by this company for our ethyl silicate in its various forms, and is not a word of general application simply meaning ethyl silicate. This company is a subsidiary of Monsanto Chemicals Ltd. and supplies various organic silicon compounds. Thus Silester O is a condensed form of ethyl silicate containing about 40 per cent. SiO_2.

We would be most appreciative if you would take steps to correct this impression by means of an editorial note or, if you prefer, by publication of this letter.

Yours Truly,
SILICON (ORGANIC) DEVELOPMENTS LTD.

Mr. H. A. R. Binney.—The British Standards Institution have appointed Mr. H. A. R. Binney, C.B., to be their new director and secretary in succession to the late Mr. Percy Good, C.B.E.

English China Clays Ltd.—Mr. R. Large has resigned from the Board of English China Clays Ltd., under age-limit conditions. Mr. R. W. C. Hobbs has been elected a director in his place.

High Temperature Control in Ceramic Manufacture

by

LEO WALTER, A.M.I.Mech.E., M.Inst.F.

THE usual two-step control mode is based on the well-known chopper bar mechanism. Fig. 5a illustrates a chopper bar recorder, and temperatures are shown on a strip chart, as can be seen on the lowered down part of the mechanism. Automatic two-step control can be achieved by means of switches, operated if the instrument pointer remains outside or inside a control contact, when pressed down by the chopper bar. For example if oven temperature is below the set point, no contact is made, and the fuel supply control valve remains open, and vice versa.

For interest, electronic control of a furnace stack damper is illustrated in Fig. 6. The measuring pointer has a small vane B fitted, which moves between an electric field created by A and C. An electronic relay magnifies high or low impulses, and actuates an electric torque unit moving the stack damper in the furnace flue.

"Floating mode" of control is achieved by using a reversing fuel supply control valve in conjunction with a temperature switch. When furnace temperature is above the desired value the valve will be moving towards its closed position, and vice versa, as shown in Fig. 7. The speed at which the valve moves can be either fixed, or it can be adjustable. Multi-speed control is also obtainable, for example having one valve speed for opening, and another for closing, or two different speeds for opening, moving quicker at first, and slower near the set temperature.

Gradual Control Modes

Instead of the abrupt valve movement used in two-step and three-step mode, a gradual and more gentle (metering) control movement of the controlling unit (stoker motor, fuel supply valve, stack damper, electrical resistance to heating elements, etc.) can be applied. The rate of heat input is gradually varied in accordance with the actual heat demand at any moment. Fig. 8 compares two-step mode with gradual mode of

(Courtesy: Elliot Brothers (London) Ltd.)

Fig. 5a. A Chopper bar recorder

Fig. 6 (Top. left). Electronic control of stack damper. Fig. 7 (Top. right). Thermostat switch and motorized valve produce floating control. Fig. 8 (Bottom). Comparison between two-step and gradual control mode of heat flow process
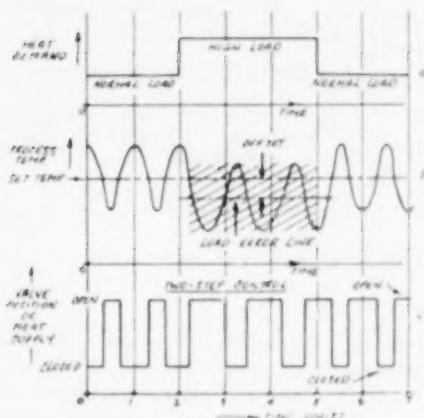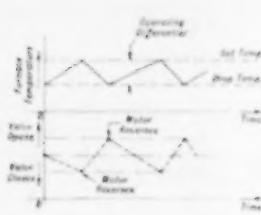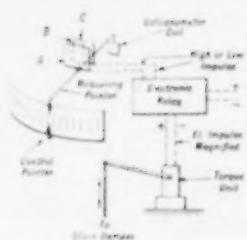
control, and curve "b" shows how the control temperature varies gently above and below the set temperature line, produced by gradual valve movement. One of the most widely used gradual electrical methods is illustrated in Fig. 9 for gradual furnace pressure control, using the potentiometric control method. The pressure impulse moves the resistance of the controller potentiometer and a balancing relay mechanism operates the motor balancing potentiometer. Any deviation of oven perature will produce movement of the motor shaft, which can operate a stoker motor, or an electrical resistance to heating elements, or a fuel control valve. Fig. 9a illustrates a control layout which automatically adjusts the oil (or gas) supply valve simultaneously with the air valve, thus maintaining the desirable fuel/ air ratio under different heat load conditions of a furnace

For gas-fired kilns and ovens, the

choice of control mode and of controller type will depend upon the type of gas burners used, and upon the required closeness of control. Position of thermocouples is important, of course, and where the furnace is divided into zones, a layout similar to Fig. 10 can be applied. Each zone has a thermocouple fitted
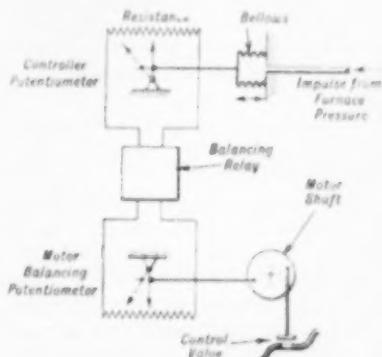

Fig. 9. Potentiometric control method
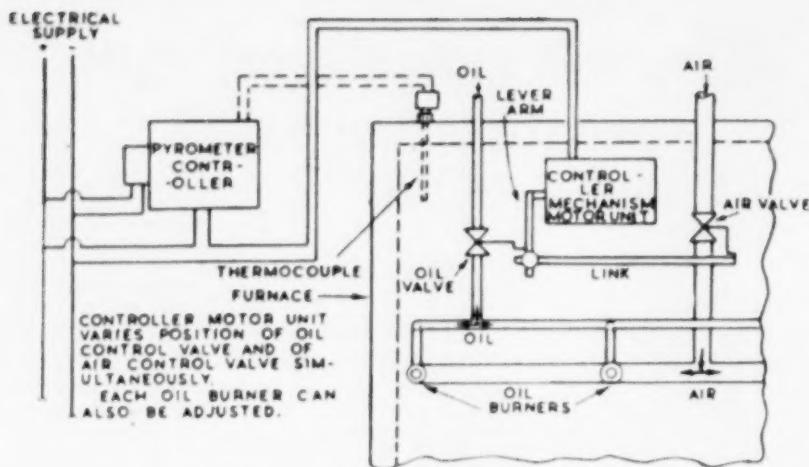
Fig. 9a. Diagram illustrating combustion control layout

with its own controller, operating individual torque units for moving the controlling unit (fuel supply control valve) for adapting the rate of heat into each zone. Fig. 10a illustrates diagrammatically three-zone control of an electrically fired furnace, using a multi-potentiometer controller, and three contacters adjust heat input to each electrical heating element individually. For star-delta connections, split windings, or with tapped transformers, three step mode of control is widely applied. Tilting vacuum mercury tubes produce "current off," "current partly off," and "current fully on" rates of heat input according to actual furnace temperature in each zone.

Typical Applications

It is impossible in a brief survey to describe the many possible applications of modern pyrometer controllers, but a few typical examples might suffice to stimulate their use. There are a great variety of controller types available in this country, and the instrument makers are only too willing to co-operate with plant engineers for solving even more elaborate control problems.

Fig. 11 shows the photograph of an International twin track electric glost kiln in a well-known pottery works, controlled by eight controlling Ardometers, connected to eight instruments. Six test thermocouples are also installed for checking the function of the controllers by measuring kiln temperatures in test positions. Fig 11a shows one six colour temperature recorder and eight Elliot temperature controllers fitted on a kiln control panel in a modern pottery. Preheating, firing, and cooling, is thus brought under close automatic control on this furnace.

An interesting installation of automatic control instruments in an overseas insulator factory uses electronic recorder controllers, similar as illustrated in Fig. 12. The porcelain insulators are made in plaster of paris moulds. Most drying ovens in this particular plant are of the continuous type. One oven, for example is 100 ft. long and has five controlled zones. Temperatures
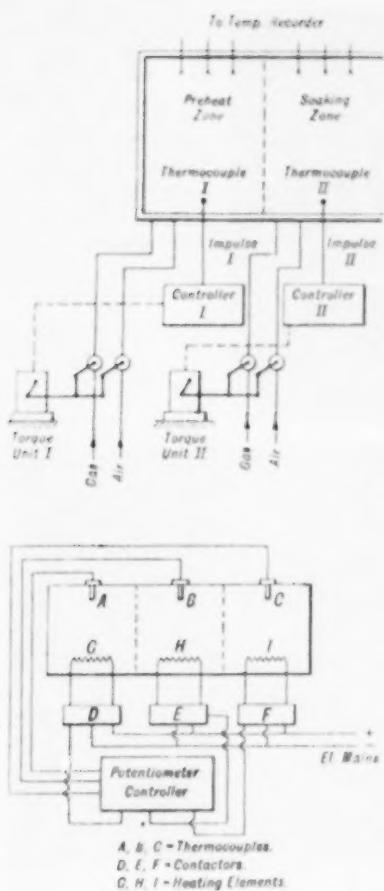
Fig. 10 (Top). Two zone control of gas-heated furnace. Fig. 10a (Bottom). Three zone control of electric furnace

are controlled at the entrance end in the first zone, but in the succeeding four zones both temperature and humidity are controlled by wet and dry bulb recorder controllers. The temperature of each zone, from the entrance to the exit end of the oven progressively increases, while the humidity decreases. The ovens are heated by grilled steam pipes located above a baffle near the top of the oven.

Fig. 11. International twin trace electric glost kiln, controlled by nine Ardometers

(Courtesy: Doulton & Co. Ltd., Burslem.)

Fig. 11a. Eight Elliot temperature regulators and one six-colour recorder fitted to kiln control panel at Burslem Pottery of Doulton and Co. Ltd.

(Courtesy: Elliot Brothers (London) Ltd.)
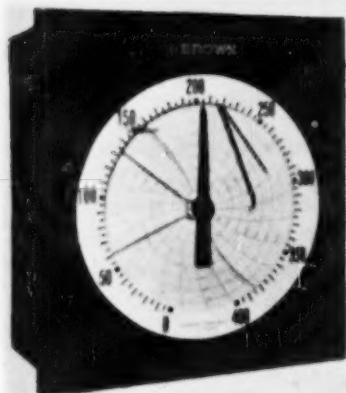
(Courtesy: Honeywell-Brown Ltd.)

Fig. 12. ElectroniK recorder-controller

The largest insulators are dried in a batch type oven, and two separate temperature controllers are used, one to regulate wet bulb temperature, i.e. relative humidity, and the other to regulate dry bulb temperature, i.e. drying temperature of the furnace. Moisture is added to the oven atmosphere in form of water sprays for slowing down the drying rate. A double cam instrument is shown in Fig. 13 for a similar method of combined temperature and humidity control.

As is known, in manufacture of insulators accurate combined temperature and pressure control is important in firing, and is used in a Harrop car tunnel kiln of the con-

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tinuous type. The tunnel kiln is
365 ft. long, holds forty-nine cars
of ware and is fired by sixteen oil
burners, eleven of which are located
in the main burner area and the
other five in the preheating zone.
Most temperatures are measured
by means of platin-rhodium thermo-
couples, part of which are connec-
ted to single point thermometers,
or part of which are checked at
definite intervals on a multi-point
instrument with selector switch. A
furnace pressure controller maintains
the kiln pressure at nearly atmo-
spheric pressure by means of a dia-
phragm motor operating a stack
damper. The diagram, Fig. 14,

Fig. 13. Double-cam
programme control-
ler for combined
temperature / humi-
dity control

CAMS

WET BULB

PILOTS

DRY BULB

AIR SUPPLY

AIR TO STEAM-
CONTROL VALVE

AIR TO PUMP CONTROL
VALVE FOR SPRAY WATER

LEGEND

(A) FURNACE PRESSURE
    CONTROLLER
(B) CLASS IX RECORDING
    THERMOMETER
(C) STRIP CHART RECORDING
    POTENTIOMETER
    (RECORDING T/c NO 2)
(D) STRIP CHART RECORDING CON-
    TROLLING POTENTIOMETER
    (RECORDING T/c NOS 7 & 9,
    CONTROLLING T/c NO 7)
(E) INDICATING POTENTIOMETER
(F) ROTARY T/c SWITCH
(G) OIL BURNERS

NOTE

NO'S 2 TO 18 REFER TO
THERMOCOUPLE LOCATIONS
NO 1 IS THERMOMETER BULB

Fig. 14. Controls
for car tunnel kiln
of continuous type

(Courtesy: Honeywell-
Brown Co., Philadel-
phia, U.S.A.)

shows the above instruments, which are assembled on a control panel.

A typical furnace panel of British make is shown in Fig. 15, consisting of six pyrometer controllers of the indicating type, and six pyrometer recorders. Signal lamps are provided beneath each controller, and main switch with fuses and the junction boxes are behind the 6 ft. 6 in. high iron framed panel surface.

Recently more elaborate control schemes have been put into operation in potteries in this country, but it requires longer experience before same can be described in detail. In conclusion the writer would refer to the Bibliography, and to instrument makers' literature for more information on the subject of automatic process control in general.

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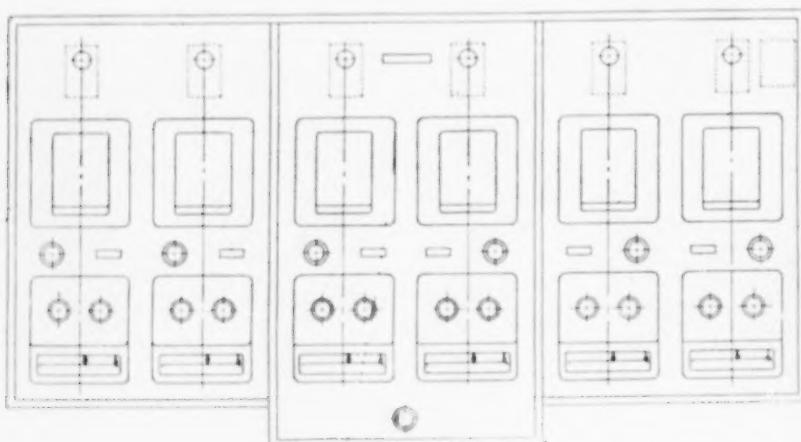
(Courtesy: Negretti & Zambra Ltd.)

Fig. 15. A control instrument panel

REFRACTORIES AT WORK

I. A MODERN WATER GAS PLANT

Illustrations by courtesy of Humphreys and Glasgow Ltd.

It is often overlooked that whenever high temperatures are considered, frequently the heart of the installation is the refractory lining. In the carburettor, superheater and generator temperatures in excess of 1,000° C. are encountered, and it is the refractories used which determine their useful life. Since, however, they are hidden from view there is a tendency for them to be overlooked.

CARBURETTED water gas plants are being constructed today in unit daily capacities ranging from 200,000 c. ft. to 6,000,000 c ft. of 500 B.Th.U. gas. They operate automatically by water or oil hydraulic power and incorporate a water-sealed self clinkering generator with annular boiler, separate checker brick filled carburettor and superheater, vertical tapered waste heat boiler, automatic coke measuring and charging machine, back run

process, proportionate system of secondary combustion and every modern feature. Fig. 1. illustrates a modern plant with self clinkering generator having a daily capacity of 1,000,000 c. ft.

A small unit having a daily capacity of 200,000 c. ft. is shown in Fig. 2. The generator on this size of plant consists of a simple brick lined vessel with a top coke charging door and cleaning door at grate level.
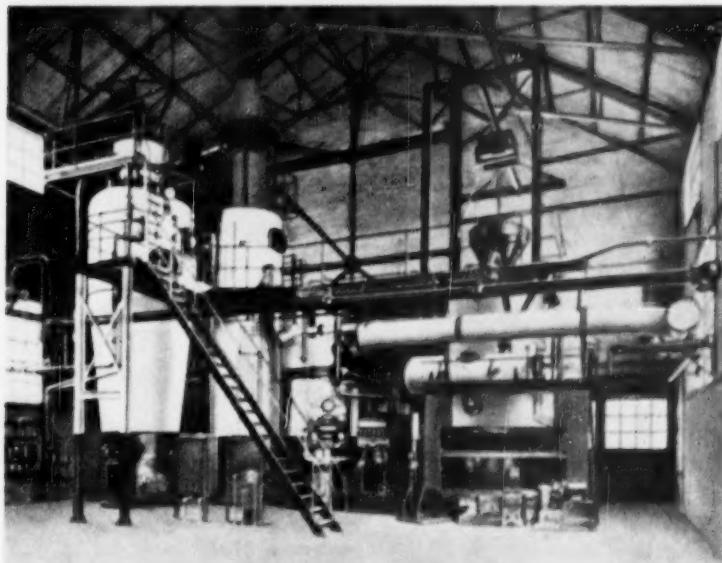

Fig. 1. A modern self clinkering generator with daily capacity of 1,000,000 c. ft.

Blue water gas plants are being constructed in unit daily capacities ranging from 100,000 c. ft., to 10,000,000 c. ft. The difference between this type of plant and the carburetted water gas plant is that a single recuperator is provided in place of the carburettor and super-heater.

Operating Cycle

In order to appreciate the purpose of the various components of the modern carburetted water gas plant, it is essential to have a clear under-

more efficient the water gas process, but a limiting point is reached when the advantage gained by shortening the cycle is equalled by the loss due to the increased proportion of cycle time occupied by valve movement and purges. The relative durations of the phases depend upon the characteristics of the fuel, but a typical cycle would comprise 40 per cent. blow, 35 per cent. total up-run and 25 per cent. back-run.

Blow

During this phase, air is admitted
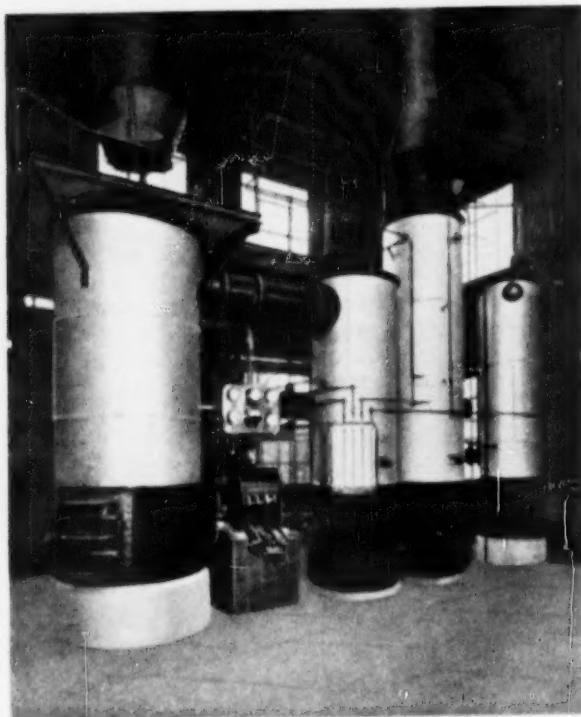
Fig. 2. A small unit with a daily capacity of 200,000 c. ft.

standing of their function in the operating cycle.

The modern carburetted water gas operating cycle comprises three phases : Blow, up-run and back-run, and these are illustrated diagrammatically in Figs. 3, 4, and 5.

The cycle is normally of 2½ or 3 min. duration. In theory, the shorter the length of the cycle, the

to the base of the generator through the generator blast valve, passing upwards through the fuel bed where it burns part of the fuel, thus increasing the heat content of the fuel bed. The gases leaving the fuel bed contain carbon monoxide in a proportion which increases as the blow progresses. The potential heat in these blow gases is released as
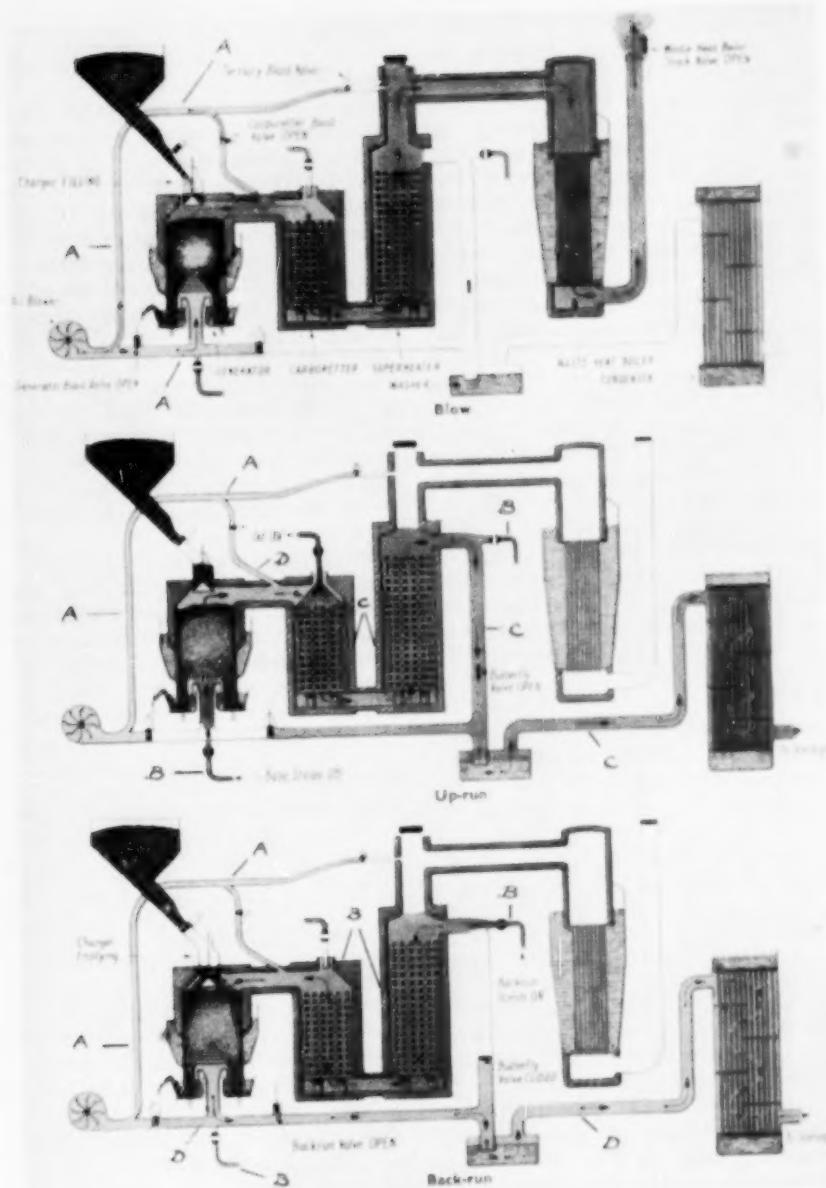
Fig. 3 (Top). Blow. Fig. 4 (Centre). Up-run. Fig. 5 (Bottom). Back-run

A—Air
B—Steam
C—Carburetted water gas
D—Blue water gas

efficiently as possible by admitting an increasing quantity of secondary air to the connection between the generator and carburettor thus burning the gases in the carburettor and superheater, and storing the heat in the checkerwork. After passing through the carburettor and superheater, further heat may be removed by passing the gases through the waste heat boiler before discharging them to atmosphere.

When manufacturing carburetted water gas of low calorific value, less heat need be stored in the carburettor and superheater, and by burning a proportion of the blow gases after they have passed the checkerwork in the superheater, additional steam can be produced in the waste heat boiler.

To obtain the highest possible efficiency, it is beneficial to use as high a blow rate as possible, while still producing sufficient potential heat to maintain the temperature of the carburettor and superheater.

Up-Run

At the completion of the blow phase the blast valves are closed, steam is admitted to the base of the generator, and, after a suitable interval to purge the vessels of inert blast gases, the stack valve is closed. Blue gas produced in the generator, passes forward through the water seal in the washer to the holder. Immediately after the stack valve closes, gas oil is sprayed into the carburettor, and the oil gas formed in the carburettor and superheater passes forward in mixture with the blue water gas.

All the oil required to enrich the blue water gas to the required calorific value of the final gas is admitted during this phase. In modern installations, it is usual to obtain over 1½ therms from the gasification of 1 gal. of gas oil. Towards the end of the up-run, the oil valve is closed to ensure that all the rich oil gas is swept forward into the washer by the blue water gas before

the next phase of the cycle commences.

Back-Run

During the back-run phase, the direction of gas flow is reversed. Steam is admitted at the top of the superheater, and passes through the cracking vessels to the top of the generator, thus returning heat to the fuel bed in the form of superheat in the steam. The blue water gas produced in the generator passes directly from the bottom of the generator through the back-run main to the washer and holder. At the completion of the back-run, the gas flow is reversed momentarily to purge the base of the generator of combustible gases before admitting air at the recommencement of the blow phase.

In practice, there is a wide variation in the characteristics of the fuels charged into the generator, and the optimum conditions are obtained and maintained in the fuel bed by correct adjustment of the quantities and rates of air and steam supply during the three phase cycle.

Blue Water Gas Cycle

For blue water gas manufacture there is no heat required for cracking the enriching oil, and as high a blow rate can be utilised as the fuel in use permits. Thus a better generator efficiency can be obtained while at the same time the duration of the blow period can be reduced.

In plants specifically designed for blue water gas production, the up-run gases are usually passed through the waste heat boiler. This is not possible on carburetted water gas plants owing to the deposition of tarry matter in the tubes.

Self Clinkering Generators

The self clinkering generator consists of an upper stationary part which comprises the generator proper and a lower rotating part comprising the self clinkering grate. The upper stationary part varies

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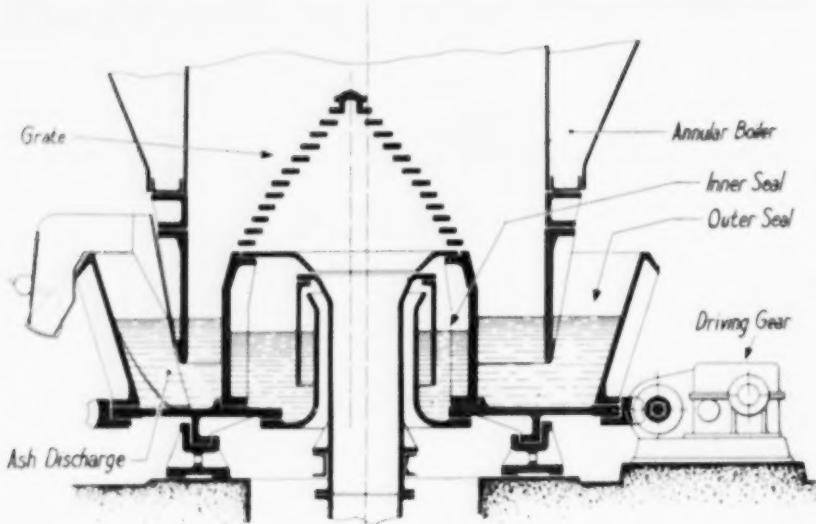
Fig. 6. Water sealed self clinkering generator

little with different designs of generator and usually comprises an annular boiler surrounding the active part of the fuel bed, and above that a refractory lined gas chamber to which is attached the coke charger, gas offtake branch, etc.

The proper operation of the self clinkering generator depends on there being no hindrance to the des-

cent of clinker as it is formed in the fuel bed. With brick lined generators there is a tendency for molten clinker to stick to the brickwork and under certain conditions, particularly when gasifying a fuel containing a high fusion temperature ash, to accumulate there. Replacing the refractory lining by an annular boiler solves the problem very satisfac-
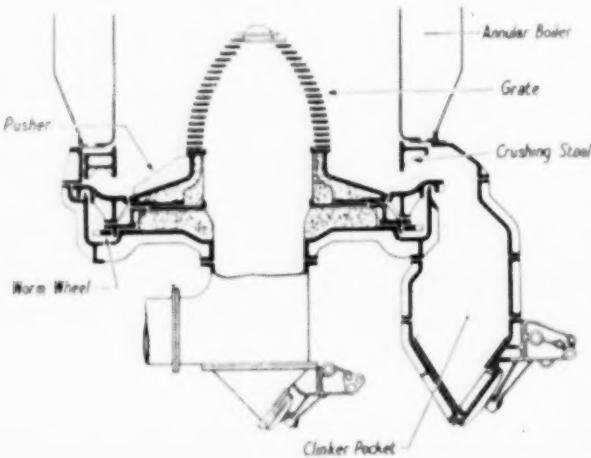
Fig. 7. Dry sealed self clinkering generator

torily, as clinker will not stick to the relatively cool wall of the boiler. It must be stressed, however, that this is the sole reason for the presence of the annular boiler, and heat is thereby lost which might otherwise be used in the process; it is however, converted into steam at maximum efficiency.

There are two main types of self clinkering grate. The one most commonly installed incorporates a continuous ash discharge through a water seal, while the other is totally enclosed, the ash being discharged into pockets which are emptied periodically.

The arrangement of the water or wet sealed self clinkering generator is shown in Fig. 6. The inside of the generator is sealed from the atmosphere by water and the grate is slowly rotated electrically or hydraulically. The grate is mounted eccentrically on a base plate, which turns in a continuous skid track. The eccentric rotation of the grate agitates the ash zone and assists the discharge of ash and clinker into the outer annulus of the ash pan, where it is forced up a static ash path and over the lip of the ash pan into a container.

The dry sealed self clinkering generator is shown in Fig. 7. This type of grate, which is rotated in the same manner as the wet sealed type, is usually mounted concentrically on a base plate, and means are provided for guiding ash and clinker into the pockets.

Hand clinkered generators are used on plants having a daily capacity of less than 1,000,000 c. ft.

HARD METAL

A FILM under the above title has just been produced by Protolite Ltd., Central House, Upper Woburn Place, W.C.1. It deals largely with the use of cemented tungsten carbide which, although it has been used commercially for more than twenty-five years, was introduced into the pottery industry only about five years ago. At the beginning it was applied to the manufacture of pottery made on hand-turning tools, but subsequently a use was found for it in the profile tools used for making cups, saucers and plates. Experience has shown that it was not only successful here, but showed many economies in use as compared with other materials.

Additions to Range

The range of tips and tools now covers hand-turning tools in thicknesses down to ⅟₂ in. and profile tools, as well as spreader tools up to 12 in. in length. When it is necessary, tips can be supplied for the pottery manufacturer to make up their own tools. It is pointed out, however, that extreme care must be taken in the processing of hard metal, and only the recommended grinding procedure advocated by Protolite Ltd. should be adopted.

In the film itself, the introduction shows a world map illustrating the chief mining centres of Wolfram and scheelite the principal ores of tungsten. The concentrated ores are seen in the magnetic separation plant and subsequently through the various processes in the chemical plant, pointing out the careful control necessary before pure tungstic acid is produced. The acid is then taken to the hard metal plant where it is reduced to tungsten metal powder, subsequently mixed in the correct proportions with carbon, cobalt, titanium and other elements necessary before the final sintering process which brings the metal to its extremely hard state.

The film continues to show the grinding and lapping operations necessary on the sintered carbide before being suitably mounted and finished for use as tools, dies and wear resisting parts for industrial use.

Applications of the finished products as used in the engineering, woodworking and ceramic industry bring the film to a conclusion.

The running time of the film is fifty minutes and copies are available for showing in works, canteens, etc. Application to borrow the film should be made to Protolite Ltd.

Mr. A. H. Haddow.—We learn from Modern Industrial Ventilation and Oven Co., 70-76 Alcester Road South, King's Heath, Birmingham 14, that A. H. Haddow, has joined this company, to take charge of the sales department.

SOME NOTES ON PLASTER

THE main chemical constituent of plaster is gypsum, which is usually compounded with various fillers, binders and colouring agents. There is therefore a wide range of different plasters having differing qualities of strength, grain, porosity, density and colour; also, the various mixes of plaster have characteristic ways of "setting-off," hardening and drying out. The various plasters have been found to be suitable for certain jobs and thus we have

Additives to the basic plaster may make considerable change in the quality of the resultant material: such substances as mill-puff, cotton linters, papier mâché and asbestos are often added to form fibrous plaster which has some degree of flexibility and lower density. Sometimes dextrine, glucose, sugar or bark-gum is added to plaster to close the grain and bind fibres thereby giving a fine hard surface. A good binder is formed by the ad-
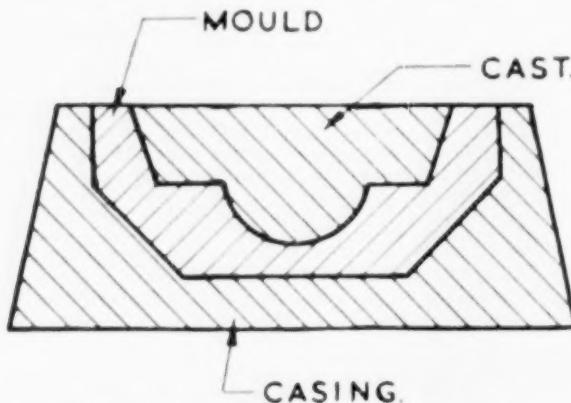
Fig. 1. Section through typical "open" (flat-back) mould.

classifications such as "common grey" plaster, "dental plaster" (made in three or four grades of hardness and purity), "pottery plaster" (made in many grades), and such proprietary mixes such as Keen's Cement, Alabastine, etc. All these plasters have the self-setting characteristic and need no firing; after mixing with water they harden after a short time by virtue of their own chemical actions.

dition of water-soluble resinous substances and generally the addition of sodium chloride (common salt), or potassium carbonate results in shortening the time taken to set-off. It is essential to remember that any organic material added to the plaster will make it unsuitable for firing if this is required in a later process, and also that in order to prevent putrefaction or the growth of fungi the plaster must be dried out as thoroughly and quickly as possible without weakening it.

The techniques of plaster fabrication are based upon the physical

and chemical proportions and properties of the material. In mixing, the plaster in dry powder form is added gradually to clean water until the desired ratio of plaster to water is achieved; the ratios vary from one part by volume of plaster to two of water, up to two parts of plaster to one of water, and depend upon the nature of the plaster and additives, and also on the air and water temperatures, the setting-off the cast is much weakened by being too wet, and while it is desirable to get the water out of the plaster quickly, the use of hot air or radiant heat will deteriorate the strength unless the temperature is kept below about 60° C. It should be noted that the chemical action in setting-off produces an appreciable rise in temperature and maintains it for a period dependent upon the mass. During the first few hours after set-
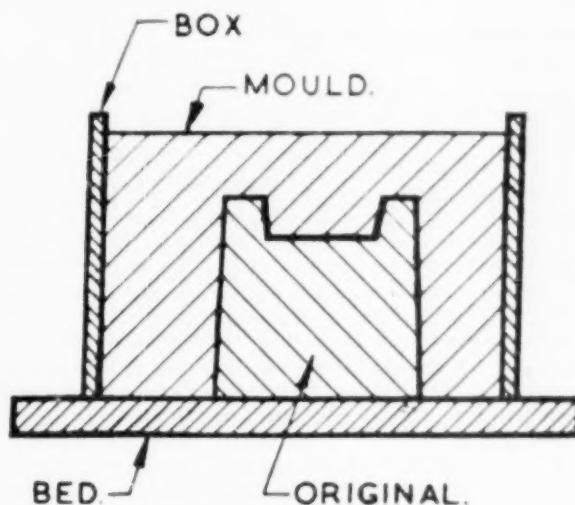
Fig. 2. Making an "open" mould by pouring

BOX

MOULD.

BED.

ORIGINAL.

time required and the hardness and other qualities desired in the hardened plaster. The mix shows a progressive tendency to thicken as the plaster is added, and for general purposes is about the consistency of cream when ready for casting. After a short time the plaster though still very wet is no longer fluid, but is still capable of being deformed and hardening in the new shape. When deformation is no longer possible, the plaster is said to be set off; although solidified it continues to develop strength noticeably up to about 6 hr. after setting-off, and then strengthens at a decreasing rate until practically dry. During this maturing time, and particularly during the first few hours after setting-off ting-off plaster exhibits a peculiar property in that if its form is crushed it tends to re-amalgamate and reharden though with somewhat reduced strength: this enables minor surface defects to be repaired soon after casting.

Plaster may be joined to practically any other substance by simply being poured on in the plastic state, provided that the surface of the solid body to which it is joined is well-roughened and "keyed" and that if the substance to which the plaster is joined is water absorbent, it shall be treated to prevent water being drawn out of the plaster. When joining plaster to plaster it is usual to apply several coats of french polish to the solid half of the

joint, having first provided keying in the form of dowel holes.

After hardening, plaster may be sawn, drilled, shaped, chiselled and so forth, and may be filed and surfaced, and even threaded, using coarse threads with plenty of crown clearance between male and female halves.

These briefly are the basic techniques which are combined and modified to suit the various types of work.

Mould Materials for Casting Plaster

The moulds in which plaster is cast may be of aluminium alloy, varnished wood, plaster, wax, gelatin, or synthetic elastomers, etc. Aluminium is usually used for mass production of standard lines: the moulds are robust, and last indefinitely, but must be of sufficiently light construction to allow for expansion. If proper allowance is not made in a rigid mould the surface of the cast is spoilt and acquires a characteristic "dragged" appearance, which is avoided to some extent by the use of lubricants.

Varnished wooden moulds are not widely used because of high cost, and generally are employed only on single-part open-back moulds which present no expansion problem. Closed wooden moulds, and metal moulds of heavy section are used generally only for production of fibrous plaster which has a fair degree of elasticity.

Where plaster is used as the mould material it has the same expansion as the cast, and provided the mould is slightly damp the heat will travel quickly enough to prevent the setting up of any serious strains which might lead to cracking.

The waxes such as paraffin wax can be used with very great accuracy and are frequently employed where single casts are required: they may be used to take the impression of very minute detail which is greatly to be desired in art work especially.

The non-rigid mould materials such as damp clay, plasticine, gelatin and the various thermoplastic elastomers are not used as mould materials where it is intended to work to fine limits, but find special uses according to the casting problem.

Rigid and Flexible Moulds

Where wax is used as the mould material for casting plaster, little precaution need be taken as regards undercuts as such a mould is regarded as a "waste-mould;" that is, it is used once only and it is necessary to break the mould to remove the cast. Other materials, especially thin plaster, may also be used to make waste-moulds.

Other moulds may be generally described as either one-piece (open) moulds, or "part-moulds" which, as the name implies, are made in sections to facilitate the removal of the cast. Flexible moulds of elastomer or gelatin are sometimes slit to enable the cast to be taken out, and except for the heaviest undercuts they give no trouble, provided that the sections cast are of sufficient thickness and strength to withstand damage during removal from the mould.

All non-flexible moulds must be constructed with the greatest care to ensure that the mould has no undercuts or "keys" which will prevent the extraction of the cast, and in part-moulds each part must be constructed on this principle.

Poured Moulds

Moulds for casting plaster and other materials may be made by two main methods: first, machining or carving a solid block of the material to the required shape; this is rather a slow and costly process but is widely used in the glass industry for the manufacture of repetition moulds in chilled cast iron; part of the form is usually cast in the block to reduce machining and hand working to a minimum. The second mould making method (Fig.

ROTATING
STRICKLE

Fig 3. Strickle
methods

STATIONARY
STRICKLE

SPINDLE
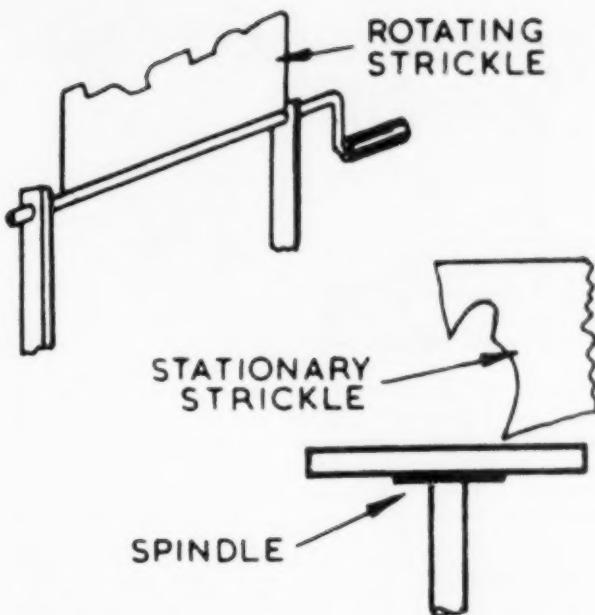
2), is where the mould is poured in liquid or molten state into a receptacle which contains a solid object the form of which it is desired to leave on the inside of the mould.

When making a poured plaster mould in this manner it is necessary to fashion a suitable receptacle to hold the mould material: sometimes this moulding box is made of wood or metal and is collapsible, and sometimes the box is purely a temporary affair formed out of pieces of glass, wood or metal sheet and held together with plasticine or clay, or made of plasticine only. The object is fixed in position in the box and the mould material is poured in.

This method is suitable only for making one-part moulds which, of course, have flat backs, although it should be noted that with some of the new elastomers a totally enclosed mould in one piece can be made. Making part-moulds by this method is possible but it is necessary to approach the problem

bearing in the mind the necessity for making a smooth parting line. If the article is at all complicated or much undercut it is best to set about making a proper part-mould. Part-moulds in plastic materials are possible, but they do not register very well even if mounted in a rigid box; therefore, if accuracy is required a plaster part-mould is the best method of reproduction for small quantities.

Strickling

Strickling is widely employed in loam or sand moulding; it consists of cutting a profile in thin wood or metal sheet and rotating or moving the strickle board (as it is called), through a mass of sand or loam to form an impression of the desired shape (Fig. 3). A similar technique may be employed to form plaster while it is in the semi-plastic state just before setting off. By this means curved surfaces both convex or concave, in one or two planes may be formed.
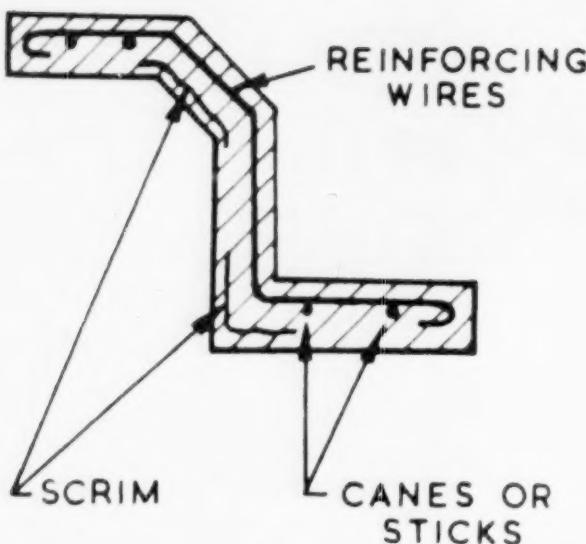
REINFORCING
WIRES

SCRIM   CANES OR STICKS

Reinforcement

Plaster is a very friable substance which tends to crumble under concentrated pressure, but in the mass it is deceptively strong provided only that pressure is evenly distributed and does not involve any strains. It will shatter readily under shock, and unless it contains a fair proportion of fibrous matter, has very little elasticity. It is therefore necessary to use care in designing plaster solids, and where the shape is one which contains thin sections, or where unequally distributed loads have to be applied, reinforcement is necessary (Fig. 4).

Thin sections of plaster may be strengthened with iron wire, which in order to ensure a good grip on the plaster, should be allowed to rust on the surface to a fair extent before using. Where lightness is required strips of balsa wood or bamboo placed in the mould or inserted during forming will give greatly increased strength.

The most common form of reinforcement is to insert a material known as "scrim." This is a coarse woven material similar to flour sacking and should be slightly damped before insertion, or better still, squeezed out in thin plaster. Very large models can be made with facility by constructing a light frame of wire and bamboo, and which is covered with scrim tacked on with string: plaster is then applied to the outside and inside surfaces. Using this technique, large, light and strong models may be made for exhibition and other purposes.

(To be continued.)

HIGH TEMPERATURE CONTROL—*(continued from page* 636).

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High Temperature Insulating Materials*

Their Properties and Testing

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PART 1

IT is a point of some significance that much of the material used for high temperature insulation is produced by the refractories industry. High temperature insulation is, in fact, primarily a refractory material, and only secondarily an insulating material. In selecting insulation for use at elevated temperatures, two questions arise: will the material stand up to the temperature and other conditions to which it will be exposed, and is it an efficient heat insulator? The questions are always asked in that order. In discussing the properties and testing of these materials, therefore, their dual rôle should always be kept prominently in view.

In order to prepare a refractory material for use, it is generally necessary to fire it to some temperature near to that which it will experience in service. This ensures that all thermal effects, whether desirable or otherwise, are brought substantially to completion during the manufacturing process and do not continue during the material's service life.

For the purpose of this paper, high temperature insulating materials will, therefore, be defined as those insulating materials that are fired to a high temperature at some stage

of their manufacture. The definition will include diatomaceous materials, expanded vermiculite, clay and other refractory products, but will exclude asbestos and magnesia preparations, which are not normally subjected to more than a moderate degree of heating before use.

Insulation of Furnaces

When furnace designers first became aware of the many advantages of heat insulation, the choice of materials available to them was very restricted. Insulating power and refractory properties were rarely found together, and it was necessary to separate the two functions, setting firebricks inside the furnace to sustain the high temperature, and backing up the firebricks with insulating materials, which were thus protected from the full heat.

Insulation applied externally in this way did not always effect in full the expected economy in fuel consumption, for, although it impeded the escape of heat from the outer surface of the firebrick, it could not immediately reduce the flow of heat from the furnace into the inner face of the wall. It simply dammed up the outer exit and caused a reservoir of heat to form in the firebrick. Not until this reservoir was full could the insulation exert its maximum effect. This did not matter if the heat pool, once filled, remained full indefinitely

as it would do in a furnace operating continuously; but in a furnace working intermittently, this reservoir of heat is emptied each time the furnace is cooled, and much of the insulation's work is wasted.

For intermittent, and particularly for short cycle operation, it is necessary to bring the insulation into action more quickly, by taking it inside the furnace to form the furnace wall. Hot face insulation, as it is called, demands a material equally as refractory as a firebrick and having insulating properties besides.

Relative Properties

There is thus a rather wide gap between the refractory properties required in backing-up and in hot face insulation, which tend to fall into two fairly well defined groups.

The usual material for backing-up insulation is diatomite, a naturally porous earth, which may be suitable for use up to 900° C. For higher temperatures in the same position porous clay bricks must be used, or bricks containing expanded vermiculite. The latter have only recently become available in quantity.

For hot face insulation a porous brick is required with refractory properties, adequate strength, and resistance to rapid temperature changes. Hot face insulating bricks and medium temperature backing-up bricks are usually made from clay rendered porous by mixing with it a proportion of finely divided combustible material such as coal, coke, sawdust, or cork dust, which is later oxidised away when the shaped goods are fired. Other methods are available for the artificial production of porosity in clay mixtures. Clay in the form of a slip or slurry may have gas generated in it by a chemical reaction, or air may be intimately mixed with it by mechanical means. The last method in particular, yields some remarkable products, but both the above processes are difficult to operate on an industrial scale, and there is little likelihood that high

temperature insulation will be produced in quantity by either method for some time to come.

Few high temperature installations lend themselves to the use of insulation in powder form. For most purposes insulation is made in the form of bricks, slabs, or blocks, and most of the tests to be described here are applicable to such shapes.

High Temperature Insulating

High temperature insulation in many of its applications plays three parts: it is at once an insulating material, a structural material, and a refractory material. It will be useful to inquire what properties are called for by the three rôles before discussing how these can be measured.

(a) *Thermal Properties.*—The importance of thermal conductivity in an insulating material does not need to be stressed. It will obviously be the first item in any testing scheme. Since, however, the measurement of thermal conductivity is always a difficult undertaking, it is natural to look for a relationship between conductivity and other properties that can be more easily evaluated.

Low thermal conductivities are achieved by removing from a body much of the solid material, which is highly conducting, and replacing it by air, which is a good insulator. Sometimes nature has performed this service, as, for instance, in cork, asbestos and diatomite; in other cases the air must be introduced artificially. It follows that the thermal conductivity will depend on the proportion of solid material present in unit volume (i.e., on the bulk density), and in a reverse manner on the proportion of air present (i.e., on the porosity). The relationship between conductivity and bulk density is not exact, since the amount of heat transmitted across the air spaces varies in different circumstances. Further, the conductivity of the solid material varies very considerably between one ceramic material and

another, and in the same material after various firing treatments. Bulk density can therefore be used as a comparative index of thermal conductivity only in materials of similar composition and thermal history.

There is, however, a direct and exact relationship between the bulk density of an insulating brick and its thermal capacity, which is of the utmost importance in furnaces heated and cooled daily. There is no need to repeat here the many published reports on the savings in both time and fuel effected by replacing heavy firebricks by light insulating bricks in intermittent furnaces. Bulk density is therefore of primary importance in its own right.

Porosity

Reverting to porosity, it is clear that this property, like bulk density, cannot be used to predict or compare conductivities where the conducting power of the solid phase is open to doubt. In addition, much heat is transmitted across the pores by radiation, and the amount so carried depends on temperature and the size of the pores.[2] There is also a directional effect due to an orientation of the pores brought about by some manufacturing processes.[3] L. R. Barrett has developed an expression relating conductivity and porosity which allows for the effect of radiation across the pores and is thus valid for materials of different pore size. It involves the conductivity of the solid material, which is rarely known, even approximately. The expression also neglects the possibility of orientation in the pores.

Porosity should, therefore, be regarded as a first indication of conductivity, which may be disturbed by many variables.

Thermal diffusivity is rarely measured, although it enters into the calculation of furnace efficiency in short cycle operation. An approximate value can be obtained if necessary from the thermal conductivity, bulk density, and specific heat, the

last named being assumed equal to that of the average firebrick. Typical values can be found in reference books.

Reversible Thermal Expansion

Another thermal property, the reversible thermal expansion, is important, since allowance has to be made for it in furnace design. It is rarely included in the tests applied to high temperature insulation, since there is little difference between the thermal expansion of an insulating brick and that of the material from which it is made. Once again accepted values from books of reference can be used without serious error.

There is another property that affects the insulating value under certain conditions. This is the permeability to air. Some insulating bricks offer little resistance to the flow of gases through their pores, and if they are built into a furnace operating under a negative pressure cold air will be drawn into the furnace, with consequent loss of efficiency. On the other hand, if the furnace pressure is positive, there will be a flow of furnace gases through the wall. This is put to use in the so-called permeable lining furnace, where the only exit for the products of combustion is through the wall bricks. The heat that would normally escape in the flue gases is thus used to heat the walls, and there is a considerable gain in efficiency in short cycle working. Apart from this special use, however, a high permeability is not considered a desirable feature in an insulating brick.

(b) *Mechanical Properties.*—There is considerable confusion of thought at present on the degree of strength an insulating brick should possess. Furnaces are usually designed so that a wall of insulating brick carries only its own weight, and this demand can be met at extremely low strengths. But bricks that are very weak cannot stand up to transport and handling. This is the most

serious consequence of mechanical weakness.

Crushing Strength

The crushing strength at room temperature is usually accepted as an index of mechanical strength, although it is known that insulating bricks are rarely endangered by compressive forces except when sandwiched between heavier walls.

Damage in transport or in handling will depend on a number of mechanical properties, including friability, for which there is as yet no test. Once again the crushing strength is usually employed in deciding whether a brick will be particularly prone to handling losses.

If the possibility of salvaging backing-up bricks from a dismantled structure is held to be worth consideration, it would be more appropriate to measure the transverse strength.[6]

Tensile strength and the elastic properties of insulating bricks determine in part the resistance of the material to rapid changes of temperature, but this complex property is best measured directly, as will be described later.

(c) *Refractory Properties.*—Among the less desirable properties of high temperature insulating materials is the tendency, which all possess, to shrink on heating. Since shrinkage in service leads not only to cracking and its attendant troubles, but also to loss of insulating power, an attempt is made to forestall it by firing the material to a temperature near to that which it will experience in service. Most of the shrinkage then occurs in the manufacturer's kiln rather than in the user's furnace. But shrinkage is a progressive phenomenon and may continue slowly even at the temperature for which the brick is designed. Higher temperatures will accelerate it and increase its severity. Some measure of the shrinkage that may occur under a given set of conditions is

therefore essential, and for this the shrinkage on reheating for a specified time at selected temperatures is determined. A brick must pass this test before any other property is considered.

Compressive Stress

Shrinkage under the influence of temperature is much increased if the material is also subjected to a compressive stress. In furnace structures the refractories must bear the weight of the super-incumbent brickwork and possibly of the roof also. In the case of dense refractories this may form a considerable weight, and the refractoriness-under-load test is second in importance only to the shrinkage test in these heavy materials. With insulating bricks the circumstances are rather different. Owing to their insulating nature there is generally a considerable drop in temperature through the wall, and a large proportion of the bearing surface is at a temperature at which the load makes little impression. A load test at the furnace temperature is, therefore, irrelevant to the behaviour of the wall as a whole.

The effect of compressive load is of greater consequence in sprung arch roofs, for here the stress on the hot face of the bricks will be considerable. If the temperature is high enough to cause deformation, the heated zone of the bricks will yield to the pressure and the point of maximum stress will move back through the roof to a point where the temperature is low enough for the bricks to withstand the stress. This means that only a portion of the roof is bearing the weight. The refractoriness-under-load test may be useful in indicating what thickness of the roof is actually taking the load. In general, the load bearing capabilities of insulating bricks are so poor that modern practice is tending more and more to the use of suspended roofs, which are practically unstressed.

Spalling

One of the advantages of hot face insulation is the time saved in bringing the furnace up to working temperature. The low heat capacity of the walls makes for rapid heating and cooling. But since the heated face of the bricks expands while the cooler portion remains unchanged, rapid heating produces stresses in the material which may lead to the phenomenon known as spalling, i.e., cracking by internal stresses. Spalling is common to all refractory materials, and insulating bricks are especially prone to it because of their weakness. Few of them show up well in a spalling test, but there are wide variations between one brick and another, and a spalling test is generally included in the testing programme. It is generally recognised, however, that there is a marked discrepancy between the spalling that occurs in the laboratory and that which is found in service. The fundamental difficulty is in assessing the degree of damage in the laboratory test. This will be discussed in the section on testing.

Porous Refractories

Porous refractories are rapidly attacked by liquid slags, since penetration is deep and immediate and there is little solid material to offer resistance. They are also easily abraded by flying dust and scale, and it is not usual to expose them in positions where these destructive substances may be found. If conditions are not too severe a thin coating of dense refractory cement may be applied to the working face to afford some protection. The coating must adhere tenaciously to the face of the brick under conditions of rapid heating and cooling. A spalling test will reveal any tendency for the coating to peel off.

Many firebricks disintegrate if exposed to carbon monoxide for long periods at moderate temperatures. The severity of attack depends on the nature of the iron compounds in the brick; some materials are practically immune, others are rapidly destroyed. If insulation is to be used under reducing conditions, where carbon monoxide may be present, it may be advisable to examine its behaviour beforehand in the laboratory.

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THE RAPID MAGNETING MACHINE CO. LTD.

THIS company celebrates fifty years of progress this year. It was way back in 1901 that they first introduced a primer separator carrying a yoke of electro-magnets to extract ferrous from non-ferrous metals in scrap-yards. Recently it celebrated its Golden Jubilee with a large gathering of employees, their wives and friends, by a dinner and social evening at the White Horse Hotel, Birmingham. Here there were presentations of long service awards to those who had been with the company twenty-five years or more, and one of the recipients was a director of the firm. Afterwards he was enrolled with the others as a member of the "Rapid 25 Club."

The firm manufacture some eighty different forms of magnetic separators ranging from tiny ones weighing a pound or so to an 8 ton plant for removing iron from coal. In fact, whenever it is necessary to lift or remove ferrous metals there is "Rapid" equipment for the job. To give some idea of the size of the equipment made, one lifting magnet about 6 ft. in diameter will pick up 45 tons of steel castings.

Profit Sharing.—About 10,000 employees of the Associated Portland Cement Manufacturers Ltd., are to receive £151,000 between them under the company's profit-sharing scheme.

BOILER WATER TREATMENT

by

H. R. NUTTALL

BEFORE discussing the chemical treatment of feed water, something must be said about scale formation. It is well known that the scales formed in boilers by the evaporation of natural waters differ widely in composition and physical properties. Some are hard and flint-like, and adhere firmly to the boiler metal, while others are relatively soft and loose. The chief ingredients of the former class are calcium sulphate and calcium and magnesium silicates, while calcium carbonate and magnesium hydroxide are the main constituents of the latter class.

Calcium Sulphate

By far the most important scale-forming compound deposited in boilers is calcium sulphate. The solubility of this compound decreases with increasing temperature. The hottest portion of the water in a working boiler is the layer in contact with the metal surface, and it follows, therefore, that if the water is of such composition that it becomes saturated with calcium sulphate, this condition of saturation will be reached in the layer at the metal surface before it is reached in the bulk of the water. This accounts for the building up of adherent scale on the surface of the boiler metal. Calcium and magnesium silicates behave similarly.

Calcium carbonate and magnesium hydroxide, on the other hand show a small but definite increase in solubility with temperature. Thus the condition of saturation will be reached in the bulk of the water before it is reached on the metal surface, and they will be precipitated for the most part as suspended particles in the water. In practice it is found that the boiler sludge contains bits of scale which have broken loose from the metal surface, and the boiler scale contains sludge-forming compounds enclosed during the building up of the scale.

Insulating Properties

Boiler scales have marked insulating properties, their thermal conductivities being in the neighbourhood of that of firebrick. As scale forms and adheres to the boiler metal right in the path of the incoming heat units, it offers a resistance to their passage familiar to that which would be effected by an equally thick adherent layer of firebrick. This causes appreciable heat losses, but an even more serious factor is the overheating of the boiler metal which may occur. This is especially the case with the modern boilers with their higher pressures, higher temperatures and greater rates of heat transfer. It is well known that heavy scales are costly and dangerous, causing heat losses, boiler tube failures, shutdowns, repairs and replacements, and therefore heavy scales in steam boilers are no longer tolerated. It is apparent that the modern boiler should present as clean a metal surface as possible to the water. The only safe and economical way of handling the scale

problem with the modern steam boiler is to prevent scale formation by removing the scale-forming materials from the water before it reaches the boiler.

Old Method

At first the only method of coping with scale was to draw the fires, empty the boilers, crawl inside and laboriously chip off the scale. Then, so the story goes, some workmen forgot about some potatoes which they had put in the boiler to cook. When they came to clean the boiler they found that the scale formation was not as thick as formerly and that a portion of it had come down as a sludge, instead of adhering to the metal. So for many years, engineers made a practice of putting a bag of "spuds" in the boiler after every cleaning. Others, endeavouring to improve on this practice, made all sorts of strange mixtures which they placed in the boilers. At the best, the most that could be hoped for was that a smaller amount of scale and a larger amount of sludge would be produced.

Treatment for Calcium Sulphate

The formation of calcium sulphate scale can be prevented if the feed water is so treated that throughout the period of evaporation in the boiler the calcium compounds are deposited as calcium carbonate and not as sulphate. This is achieved by maintaining in the boiler a sufficiently high concentration of carbonate relative to sulphate. The control of calcium sulphate scaling by this method is also effective in preventing the deposition of the two other scale-forming compounds to which reference has already been made. Natural waters occasionally contain sodium bicarbonate in solution, and as this compound is converted into sodium carbonate in the boiler, such waters may be satisfactory from the point of view of scale formation, although they may

require treatment for other reasons. The large majority of natural waters however, do not contain soluble carbonate when concentrated in boilers, and they therefore require treatment if the conditions for scale prevention are to be maintained.

Methods in Use Today

There are two methods of treatment in common use : internal treatment by the addition of boiler compounds, and external softening treatment. It is clear from the foregoing remarks that internal treatment should be based on the addition of a soluble carbonate. The cheapest carbonate available is sodium carbonate (soda ash), and this compound has been used for many years as an internal reagent in boiler water treatment. Caustic soda is also used for the internal treatment of boiler water, either as such or as an ingredient of proprietary boiler fluid. It should be noted, that caustic soda although it prevents the deposition of magnesium silicate, is not a satisfactory reagent for the prevention of calcium sulphate scale. The reason for this is that calcium hydroxide is fairly highly soluble, and even if sufficient caustic soda is present to prevent the deposition of calcium sulphate, there will be serious risk of the deposition of calcium hydroxide as an adherent scale. Many natural waters, however, have a temporary hardness which is greater than their permanent hardness, and when this is the case the whole of the caustic soda added is converted into sodium carbonate by interaction with the calcium and magnesium bicarbonates. In the case of such waters, caustic soda, if used in the correct proportion, is a satisfactory reagent for scale prevention. There is little doubt that the majority of the proprietary boiler compounds are effective in the prevention of scale by reason of the presence of sodium carbonate or caustic soda.

Although internal treatment can

be applied with reasonable success to soft or moderately hard waters in Lancashire boilers, it is not satisfactory for water tube boilers except when the feed water is soft. The main reason for this lies in the fact that although the formation of dense scale may be prevented, the large amounts of sludge deposited from hard waters will be objectionable in boilers of the water tube type. It is, therefore important to consider the relation of the method of dense scale prevention to the external treatment of feed water by preliminary softening.

Softening Feed Water Supplies

There are two processes in common use for the softening of industrial water supplies—the Zeolite or Base-Exchange Process and the Lime-Soda Process. In the base-exchange process the calcium and magnesium compounds are converted into the corresponding sodium compounds by passage through the zeolite, and the hardness is thus reduced to a very low figure. This process, however, although effective from the standpoint of the reduction of hardness, does not necessarily give a feed water which is satisfactorily conditioned for boiler feed purposes, unless it is subjected to further auxiliary treatment.

The second well established method of water softening is the Lime-Soda process, which consists of the addition of lime and soda ash in amounts slightly in excess of those required to precipitate the calcium and magnesium salts as calcium carbonate and magnesium hydroxide respectively. The precipitated solids are removed by sedimentation and filtration. The residual hardness is slightly greater than that of zeolite-softened water. Reduction in hardness can be appreciably improved by the addition of sodium aluminate in conjunction with the lime and soda ash. By the use of this reagent the speed of reaction and settling is increased. It

is fortunate that one of the reagents used in the softening process is also the conditioning agent required in the boiler water.

Difficulties at High Pressures

Unfortunately the carbonate method of conditioning becomes increasingly difficult at high operating pressures. There are two reasons for this—first, the carbonate/sulphate ratio rises rapidly with pressure, and secondly the extent to which sodium carbonate is converted to caustic soda increases with pressure. At high operating pressures it therefore becomes impossible to maintain the carbonate/sulphate ratio without raising the caustic soda concentration to a high figure. A high caustic alkalinity may involve the possibility of embrittlement, and at high pressures it may therefore become impossible to satisfy the requirements for scale prevention without incurring risk of embrittlement of the boiler metal.

It is well known that steel in contact with caustic soda above a definite concentration can become embrittled. It is essential for the metal to be stressed above its yield point—this may happen during fabrication or during subsequent operation of the boiler.

Use of Phosphate

The obvious method of overcoming this difficulty is by the substitution for carbonate of a more stable ion capable of forming a calcium compound of low solubility. It has been shown that by the use of trisodium phosphate as the conditioning reagent the deposition of calcium sulphate is prevented even at boiler pressures as high as 1,350 p.s.i. In boiler plants operated at pressures higher than about 500 p.s.i. the feed water usually consists of condensate and evaporated make-up, and it should therefore be free from scale-forming compounds. In spite of this fact, it is generally agreed, in view of the serious effects of even minute

amounts of adherent scale at such high pressures, that conditions for the prevention of scale should be maintained owing to the possibility of contamination of the feed with scale-forming compounds as a result of condenser tube leakages and priming of the evaporators. Phosphate is now being widely used as the conditioning agent in boilers fed with distilled water. By the use of phosphate not only is the formation of dense sulphate scale prevented, by the precipitation of the calcium as calcium phosphate, but the magnesium is also precipitated as a sludge consisting of magnesium hydroxide and magnesium phosphate.

The subject of scale prevention has been dealt with at some length because it is undoubtedly of the greatest importance in modern boiler plant control. If power plant engineers would base the treatment of the boiler feed water on the methods of conditioning which have been described, they would successfully combat the difficulties associated with the deposition of dense adherent scale.

Boiler Corrosion

Having dealt with the major problem confronting boiler engineers, we may pass to the other problem—that of corrosion. The most prevalent type of corrosion encountered in boilers, heaters, piping, etc., is that known as "Dissolved Oxygen" corrosion. This is caused by the presence of dissolved air in water. Air, as is well known, consists principally of oxygen and nitrogen, these gases being somewhat soluble in water, the degree of solubility depending both on the temperature and the pressure. As the dissolved oxygen is the corrosive agent, the nitrogen being absolutely inert, this accounts for the term.

Dry iron in dry oxygen (or dry air) will not corrode. Water must be present for corrosion to take place. Furthermore, this water must be present in the liquid state. A bright piece of steel or iron exposed to the air does not corrode; but put a few drops of water on it and let it stand in the air and corrosion will take place in a very short time. Air dissolves in the water and the dissolved oxygen in this air then corrodes the metal.

Similarly, air in dry steam does not corrode iron or steel. If, however, some condensation takes place so that liquid water is formed, then the air will dissolve in the water and corrosion will take place at the spots where the metal is wet. Consequently, if the steam contains air—especially superheated steam—it is common experience that the steam lines do not corrode but that the return lines, where liquid condensate is present, do corrode.

Remove Corrosive Agent

The logical way of stopping corrosion is to remove the corrosive agent from the water. De-aerated water is non-corrosive and, in modern boiler practice, it is recognised that it is infinitely better to have a non-corrosive water than to have a corrosive water and then attempt to produce a partially protective coating on the metal. The de-aeration of water is easily accomplished by boiling it. For, while the solubility of oxygen in water is about 7 cc. per litre at 70° F. it decreases rapidly with rising temperature, being zero in boiling water.

Although dissolved oxygen is the usual cause of corrosion, there are other rather more rare cases. Corrosion may be due to decomposition of fatty oils or other organic matter yielding material of an acid nature, the presence of mineral acids, or electrolysis. These are unusual cases and the following remedies may be applied where they exist: oils and greases may be removed by proper coagulation and filtration; acid waters may be neutralised by feeding alkaline substances to them; and electrolysis may be stopped by

preventing electrical leaks, or if local, may be checked by insulation or by using metals nearer each other in electric potentials.

Priming and Foaming

As boiler feed water is evaporated into steam, the salts present are left behind and become concentrated in the liquid contained in the boiler—boiler saline. For each particular boiler, under a given set of conditions, there is a limit beyond which it is not safe to concentrate these salts because of the attendant dangers of foaming and priming. The method used to reduce these concentrations is to blow down a portion of the concentrated boiler saline and to replace it with fresh boiler feed water. The following conditions affect the foaming and priming tendency of a boiler and therefore determine the maximum saline concentration at which that boiler can be operated:

(a) Design of the boiler.

(b) Nature of the load—high ratings increase the steaming velocity and sudden steam demands cause sudden ebullition, both of which tend to form wet steam.

(c) The composition of the water inside the boiler. The make-up and return water may contain oil, vegetable or other organic matter besides the dissolved inorganic solids. Further, the internal surfaces of the boiler may be covered with sludge or scale, as in the case of boilers that have been operated with improperly treated feed water, or the surfaces may be covered with protective coverings of oily materials, as in the case of new boilers. In either event, properly softened feed water will dissolve and disintegrate these surface deposits. Therefore the boiler saline will carry these loosened materials in solution and suspension until they are completely removed and discharged from the boiler.

A number of these factors, such as the design of the boiler and the nature of the load, are usually fixed conditions for a given installation and therefore cannot be changed readily. The other conditions may be readily controlled by the use of proper methods and equipment. Failure to control the tendency of a boiler to prime and foam will result in production of impure steam, owing to the carry-over of traces of dissolved solids.

Summing up, modern steam generating plants consist of water tube boilers, superheaters and economisers, and the various accessories connected therewith, and it is necessary to consider the effect of water on each of these parts. The feed water must be treated to prevent any corrosion of the metal, which is usually due to the action of dissolved oxygen; the water in the boiler must be such that no heavy scale is deposited which would seriously interfere with the transmission of heat, involving a waste of fuel and danger of overheating of the boiler and subsequent damage; at the same time the soluble salts in the water must not be allowed to accumulate too much as priming and foaming will occur. If the steam generated is not pure, the superheater, and, of course, the turbine itself, will suffer.

INFRA-RED EQUIPMENT

PARKINSON AND COWAN (Gas Meters) Ltd., Cottage Lane Works, City Road, E.C.1. have issued an illustrated brochure drawing attention to their infra-red tunnels and panels. Emphasis is drawn towards the unit construction principle which in many cases simplifies and cheapens installation costs. In the company's infra-red laboratory there is a complete range of equipment where advice and tests on customers' samples are part of normal service facilities.

British Pottery Managers' and Officials' Association

MANIFESTO

A Statement of Aims

WE publish in full the Manifesto issued by the British Pottery Managers' and Officials' Association, under the signatures of S. E. Glover, J. L. Williams, J. S. Adams, and F. A. Timmins, respectively President, Chairman, Business Manager and General Secretary.

1. Rapidly changing world conditions, with the threat of increased competition and the return of a buyers' market, bring an ever increasing need for harmonious relations within the pottery industry. As a contribution towards this end, and with the desire that the industry should show a united front to foreign competition, the British Pottery Managers and Officials consider it expedient publicly to declare its aims.

2. Development Council

Should one be formed, we claim the right to be represented thereon. Should any other form of Council be organised, we claim equal right of representation together with the British Pottery Manufacturers' Federation and the Pottery Workers' Society.

3. Trade Association

We believe that it is desirable for the future welfare of the industry that all manufacturers of ceramic products, managers, officials and operatives should be members of their respective Federation, Association or Society.

4. Negotiations

The Association regards as of the utmost importance the necessity of having itself recognised as the negotiating body on all questions of interest to Pottery Managers and Officials.

5. Modern Production Methods

The Association perceives the wisdom of introducing new manufacturing plant and more efficient methods of production, and will loyally co-operate in workable schemes.

6. Management

An opportunity should be given to workers at the bench of attaining managerial status. It must be realised, however, that management is a specialised job, for which additional training, apart from practical knowledge, is essential.

After appointing a manager, directors should have the courage of their convictions and allow him to manage. Undue intervention by directors at shop level tends to undermine the authority of the manager, confuses the worker, and destroys the unity of purpose so essential to collective effort.

7. Training of Managers

We feel that the full course of training, as provided for managers at the North Staffordshire Technical College, allied to practical experience on the factory, should equip a manager for his job.

8. Profits

We believe that a reasonable return is the right of a shareholder who has invested his capital in the business. Profits are justified after adequate wages and salaries have

been paid. Suitable forms of profit sharing, bonus and pension schemes are added incentives to a higher standard of productive efficiency.

9. Government Relations

The function of the Government should be to stimulate and safeguard the industry and not to own or control it.

10. General Aims

This Association, which was founded in 1918, is destined to play an important role in the pottery industry.

The Association aims to encourage and promote the advancement of Pottery Management in all its aspects, by the dissemination of technical, economic and practical knowledge, and by carefully regulating its membership to include only those *bona fide* Pottery Managers and Officials whom it considers to have the necessary practical and technical knowledge and ability.

BRANCH ACTIVITIES

An Announcement

IN these days of expansion and development within the ceramic industry it is becoming increasingly obvious that pottery managers and officials will hold a key position and on them the success or failure of much of the planning will depend, and from them much of the planning must emanate.

The British Pottery Managers' and Officials' Association is the official body representing all branches of pottery management and organisation and its aims and objects may be briefly summarised as follows:

To further and protect the interests of managers and officials engaged in the industry and to assist in the improvement and development of every section and branch of the industry. Those eligible for membership are head or assistant managers, modellers, or the heads of any department having direct control or supervision of workpeople.

Branch meetings are held monthly in Longton, Hanley and Burslem, and in addition to the informal talks and discussions at these meetings the Association arrange a series of lectures by leading personalities connected with our industry. These lectures are held in the North Staffs Technical College and it is not uncommon to find that their high standard has filled the lecture hall to overflowing.

Amongst the direct benefits of membership of the Association are those of financial assistance in the case of unemployment, and, after 5 years' membership, a cash payment on the death of a member.

The Association is entirely non-political, and is always pleased to welcome new members. While it is realised that numerical strength alone is no criterion of usefulness, it is obvious that to carry out to the full its obligations to the industry, and through the industry to the country, full support must be given by all concerned in the management and organisation of pottery manufacture.

The business manager is Mr. J. S. Adams, of Sandon Lodge, Blythe Bridge, Stoke-on-Trent, and the general secretary is Mr. F. A. Timmins of 79 Riverside Road, Trent Vale, Stoke-on-Trent.

STOKE AND HANLEY BRANCH

THE first meeting of the year was held in Hanley Town Hall on Monday, 15th January, 1951, with Mr. E. T. Mayer in the chair.

The following officials were elected

for the coming year: branch secretary, Mr. G. Mountford, branch chairman, Mr. E. T. Mayer.

In addition to Mr. Mountford and Mr. Mayer the following members were selected to serve on the executive committee of the Association: W. J. Brown, E. J. Creyke, I. R. Forse, A. J. Goodwin, S. Glover, F. W. Mills and A. Seddon.

The branch also nominated the following members: president elect, Mr. D. Salt (it being the turn of the Burslem branch to fill this office). Chairman of the executive committee, Mr. W. J. Williams.

The business manager of the Association is Mr. W. J. Adams, and the secretary is Mr. F. A. Timmins.

Before the elections were held, Mr. F. W. Mills intimated that he wished to resign from the post of branch secretary, due to ill-health. Mr. Mills received unanimous expressions of appreciation for the work he has done, and his resignation was accepted with regret.

The policy of this branch, which holds its meetings in Hanley Town Hall on the third Monday of each month, is to include in its agenda for each meeting a talk given by a member on a specific subject of interest, followed by a discussion. This exchange of views and experiences is of the greatest benefit to any manager and official, and it would be difficult to conceive a more concentrated and useful collection of information and ideas, and is one of many reasons why the Association is well worth joining.

After the business of the evening was concluded a talk was given by **Mr. E. T. Mayer,** of E. T. Mayer Ltd., Furlong Colour Works, Longport, Stoke-on-Trent, on **Ceramic Colours,** and practical examples of the faults mentioned by the speaker were passed round for inspection and comments, and resulted in much interesting discussion and exchange of information.

CERAMIC COLOURS
by E. T. Mayer

IN dealing with ceramic colours, I propose to classify these into four groups: 1. Under-glaze colours. 2. In-glaze colours and coloured glaze stains. 3. Body or slip stains. 4. Enamels.

Speaking mainly of the first two it is important to assess their method of preparation. Careful selection of materials is essential—i.e. for blues—cobalt oxide of a guaranteed quality. Greens and pinks—chrome and other materials of known standards (not necessarily the cheapest). After this fine selection, the next point is mixing. This is usually done dry through a 60's mesh Lawn, but wet grinding gives better results, and more intimate mixing, resulting in a better effect of colour in the glost warehouse.

Calcination

The main purpose of calcination is to make the colour stable—that is to drive off the excess oxygen in cobalt oxide. Also the colour becomes less soluble in the glaze, and calcining also removes any volatile impurities such as carbonates and sulphates. There are different opinions on this operation, as to whether the colour should be sintered or actually melted, and also as to the number of times colours require calcining. Generally speaking most colours if well balanced, require only one calcination, but an exception to this is the chrome tin pink range. The usual temperature for the chrome tin pink range is china biscuit oven.

With under-glaze black which consists of at least three or more different oxides of which iron, chromium and cobalt are the main ones, calcination is essential to render each oxide stable to each other, and if this not done, with slight overglazing of the black colour, there is a tendency to get a separation of each oxide, usually resulting in blue edges on prints.

Grinding

The next step in preparation is grinding. First get the colour down to a minimum size by the use of the crusher, to facilitate grinding, and also to avoid excess wear on the grinding pans. Generally speaking with under-glaze colours used for banding and printing which require fine grinding, the only successful way is by the use of the pans, and there is quite a difference of opinion about the merits of grinding by pan or cylinder. Where the colour is used for machine printing, from my personal experience, we have had no success with grinding on cylinders for this purpose, and use pans.

Cylinder grinding for glaze stains and body stains is practicable, but care must be taken to obtain a proper balance of colour, pebbles and water, and also to obtain a standard grinding time. On the other hand colour must not be underground, or it gives trouble with printing, cutting of the rollers, rough and streaky effects on bands.

Washing

We next pass on to the washing of colours. Soluble salts and particularly soluble bichromate in greens must be washed out by the use of hot water. We must eliminate excess soluble borates which are contained in quite a number of colours, particularly in the brown range, as on drying these form a skin on the colour and the printer will complain about the colour being underground although it is in reality due to these borates being present. Faults found chiefly with greens and

pinks due to the excess of chromates is that the decoration has a brown halo around the print and will sometimes mask the print completely.

After drying, the colours are lawned very finely and a sample sent to the laboratory for batch testing.

Uses and Application

Passing on to the uses and application of colours, we find with under-glaze banding colours there are three methods of application:
1. The use of gum and water as a medium (pass to the dipper).
2. The use of fat oil and turpentine (harden on).
3. The use of fat oil and turpentine plus the use of the acid treatment (pass to dipper).

Many times I have stressed my favour in the use of the second method for although it is more costly the general effect is considerably better and you get less loss in the glost warehouse. The use of gum and water for banding I do not recommend and the inevitable fault you will run into, is the colour rolling due to excess gum being used. With regard to the third method, the use of acid in any way is detrimental to colours and should be avoided.

From the printers point of view, the use of first-class materials, printing oils, etc., is essential and the amount of dirty ware seen today with printed patterns, particularly blue, is due to cheap oils, badly boiled oils, bad printing and carelessness in transferring and washing off. Dealing with some of the common faults found with under-glaze colours in banding and printing, we get ironing found on mazarine blue bands. This fault shows as a reddish metallic patch on the band, and the causes are excessive cobalt in the colour, excessive application, thin glaze on the band, and can be remedied by washing the band over with glaze.

Blistering and Striking

Blistering occurs in under-glaze and on-glaze colours, when they are badly calcined and this fault predominates in blues, due to the partial transformation of the cobalt oxide to the monoxide. Occurring with this fault we can get the colour displaced and flying to the other parts of the ware. Manganese colours are bad offenders in respect of blistering. Sulphates in the colour and also in the glaze give blistering and the use of calcium

sulphate (plaster) as a dope is not advocated.

Striking of colours is a typical fault with mazarine blue bands, the usual symptom being the colour band actually being transferred from the face of the flat ware to the back of the ware above. This is caused by the ware being placed whilst still damp with no clearance between the ware. Also excessive dope, calcium chloride or sulphate in the glaze will cause trouble. Sulphates in the oven atmosphere break down and combine with moisture producing sulphuric acid, which attacks the cobalt blue band.

Peeling

Peeling is a typical fault found with under-glaze matt blue. This colour is very refractory, due to its high alumina content. This produces resistance to the glaze and the latter does not penetrate the colour. Thus, the colour is not fixed to the body, and the glaze and colour are liable to peel. On the other hand if we try to offset this hardness by the use of soft fluxes we do not improve this fault, and this is aggravated by hard fired biscuit ware.

Reverting back to the use of banding colours, many faults develop through the human element, i.e. excessive weight of colour, giving with blues—black bands. Cracking and rolling of maroon and green colours. Different types of hardening on processes affect colours, that is, the use of the enamel kiln, glost tunnel oven, special continuous hardening on kilns, and the Sherwin and Cotton kiln, all of which have a bearing on the finished result. We also have to take into account the variety of glazes that are being used which influence colours to a considerable degree.

In the case of the chrome tin pink colours, the three main ingredients used in the preparation of this colour are—tin oxide, whiting and potassium bichromate. This colour is generally twice calcined at china

biscuit temperature, but the higher the temperature the better the finished product. The tin oxide acts as a mordant (colour carrier) and it also resists the action of glaze and so protects the colour.

Some of the faults which occur with chrome tin pinks are milkiness and scumming due to badly calcined colour which makes the tin more soluble in the glaze and so dissolves more readily. When the glaze is cooling the tin is thrown out on the surface of the colour usually as a white scum. Purpling is due to high alkali content which tends to increase the solubility of the colour and so tends to destroy the tone, usually causing it to revert to a puce colour. Chrome tin pink colours tend to be earthy, do not deliver well from engraving and tend to band badly. This is usually remedied in banding by the addition of a percentage of glaze.

CHANCE BROS.

BEST wishes to Miss Rosemary Garland, Press Officer to Chance Bros., who was married in January, 1951, but who will still continue to handle the editorial publicity for the company.

Chance Bros. are playing an important part in the Festival of Britain and are one of those few firms who also participated in the great Exhibition of 1851. 1951 is also the centenary year for Chance Bros.

The shot tower on the South Bank of the Thames is to be converted into a lighthouse where most of the up-to-date all-electric apparatus will be installed and controlled from the Whitehall office of the company by the medium of V.H.F. radio.

THE STURTEVANT ENGINEERING COMPANY LTD.

WE have received Publication No. 6902 replacing the previous number 6901 relating to high efficiency Cyclone Dust Collectors from the Sturtevant Engineering Co. Ltd., Southern House, Cannon Street, E.C.4. It points out the developments arising in dust collection necessary with the use of finer grinding and polishing materials.

A Review of
TECHNICAL CERAMICS

1.—PROPERTIES

THE technical ceramics are required by (1) the electrical and electronic industries (electrical porcelain, sparking-plug installation and ceramic dielectrics for electronic equipment); (2) the chemical industries; (3) as heat resistant ceramics for normal and high temperature users; and (4) a number of other ceramics for special or specific applications.

Nature and Composition

Ceramics whiteware body is composed essentially of a flux, a plastic and a non-plastic. The non-plastic provides the skeleton held together by the glass phase (or bond) developed from the flux on firing. The plastic content, normally imparted by plastic clays or by organic additives gives workability and aids casting.

The general composition of whiteware bodies is given in Table 1.

Recent developments have been towards obtaining lower maturing bodies, the use of more active fluxes, combination of fluxes, higher flux content, and especially more finely ground raw materials, providing means for lower firing. Any higher cost of raw materials is offset by fuel and refractory economies.

A number of vitreous bodies have been developed, which vitrify at relatively low temperatures. A cone 4 (2129F) vitreous body is being produced largely from nepheline syenite. Nepheline syenite-talc mixtures provide fluxes for vitrified bodies maturing in the firing range cone 02 to 2 (2003 to 2075 F). Nepheline syenite-talc-spodumene mixtures have been recently recommended for fluxes for low temperature vitreous bodies. The firing temperature of a normal cone 10 (2300F) china composition can be lowered by two or three cones (95 to 120F) by replacing the feldspar content by nepheline syenite. As already indicated, other material advances will be discussed under specific ceramics.

Methods of Production

The principal methods of forming

TABLE 1—GENERAL COMPOSITION OF SOME CERAMICS*

	Chemical Porcelain Cone 12-14 (2190-2534F)	Normal Porcelains Cone 12-14 (2190-2534F)	Electrical Porcelains Cone 11-13 (2345-2462F)	Vitreous China Cone 10-11 (2300-2345F)	Sanitary Porcelain Cone 9-11 (2282-2345F)	Fine Earthenware Cone 8-9 (2237-2282F)
Feldspar or Nepheline Syenite	20-25	20-28	28-38	10-18	30-36	10-16
Whiting	0-1	0-1	0-3	0-1·5	—	—
Dolomite	—	—	—	0-3·0	—	—
Ball Clay	0-5	—	15-35	10-20	16-25	20-35
Kaolin, China Clay	50-58	40-50	20-35	20-30	20-30	20-35
Silica (200 Mesh "Flint")	10-15	22-35	15-25	30-38	20-30	32-36

* Reference to Orton Cones.

TABLE 2.—SIGNIFICANT PROPERTIES OF TECHNICAL CERAMICS
AND FACTORS AFFECTING THEM

Property	*Conditions in Ceramic Affecting Properties*
Mechanical and Physical	**Individual Mineral Constituents**
Specific Gravity	1. Chemical compositions
Water Absorption	2. Character of crystals
Colour	(a) Shape and size of individual crystals
Hardness	(b) Cleavages of individual crystals
Resistance to Abrasion	(c) Co-efficient of elasticity of individual
Softening Temperature (Also	crystals
Thermal)	**Glass Phase**
Tensile Strength	1. Chemical composition
Compressive Strength	2. Co-efficient of elasticity
Resistance to Impact	**Relation of Crystal to Glass**
	1. Equilibrium attained and ratio of
	crystal to glass phase
	(a) Firing time and temperature
	(b) Rate of cooling
	(c) Atmosphere
	2. Wetting power of crystal and glass
	Homogeneity
	1. Fineness of grinding
	2. Mode of addition of minerals
	3. Method of preparation
	4. Firing conditions
	Glaze Frit
Thermal	1. Chemical composition of crystal and glass
Co-efficient of Thermal Ex-	phases
pansion and Uniformity of	2. Co-efficients of expansions and elasticity
Curve	of each
Heat Conductivity and Dif-	3. Bond between glass and crystals
fusivity	4. Size of crystals
Softening Temperature (Also	5. Glaze Frit
Mechanical)	6. Homogeneity
Te Value (Also Electrical)	7. Porosity
	8. Firing cycle
Electrical	1. Chemical composition
Dielectric Strength (Puncture	2. Mineralogical constituents
Voltage)	3. Electrical properties of both crystals and
Te Value (Also Thermal)	glass
Power Factor	4. Porosity
Dielectric Constant	5. Surface
Capacity Change per Degree C.	
Chemical	1. Chemical composition of crystal and glass
Resistance to Acids and	phases
Alkalis	2. Ratio of crystals to glass
Operation as Contact Agent	3. Size of crystals
in Catalysis	4. Homogeneity
Permeability	5. Firing cycle of body
Filtering Properties	6. Porosity and size of pores

ceramic shapes from the pre-
pared body composition are referred
to as jiggering, casting, extruding
and pressing. A finishing operation
generally follows, which can vary
from only inspection to intricate
machining in the dried state,
depending on the product.

Jiggering, now largely automatic,

is best brought to mind by the old
potter's wheel. In casting, a sus-
pension of the body composition is
poured into a gypsum mould which
absorbs moisture, building up a
shape to the desired thickness, and
the excess is poured off (drain-
casting); some items are cast solid.
De-airing pug mills are used in

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extruding a number of products which are suitable in shape. Pressing, especially with hydraulic or automatic presses, has gained extended use where adaptable. In each operation close control is required as needed to attain necessary workability or castability. The properties of the fired ceramics will vary with forming operations as they affect the density of the pre-fired shapes.

The formed ceramic is referred to as being in the "green" state and, when subsequently dried, to the "leather-hard" state. If the ceramic is to be glazed, the glaze of proper consistency and composition can then be applied (normally sprayed on), and the body and glaze matured in a single firing; sometimes it is desirable to mature the body first (bisque-fire), apply the glaze of proper consistency and composition for a subsequent lower temperature firing (glost-fire), which matures the glaze on the body. More reference

will be given later to fabrication techniques where they differ from the normal operations.

The properties of such ceramics, and the factors governing these properties are given in Table 2.

Chemical Resistance

Practically all ceramic products have high chemical resistance, being relatively inert to all chemicals except hydrofluoric acid and, to some extent, hot caustic solutions. Chemical porcelain, stoneware, glass and glass-lined steel fulfil most of the requirements for chemical equipment and handling of chemicals. All technical ceramics will withstand prolonged heating at a minimum of 1,830° F., and many will withstand higher operating temperatures, e.g., the refractory porous and vitrified bodies as used for radiant heaters, burner parts and pyrometer tubes.

The mechanical strength of ceramics varies considerably, depending

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on composition and degree vitrification. Ceramics are normally much stronger under compressive loading than in tension. The stress condition of the outer layers greatly affects the strength. For example, the flexural and tensile strength of a normal porcelain can be increased or decreased as much as 40 or 50 per cent., depending on the stress condition in the glaze.

The thermal expansion of the body, and the effects of volume changes due to inversions, are important to consider in designing the glaze so that it is under the optimum stress condition (compression) and, consequently, the maximum (practical) gain in mechanical strength and thermal endurance of the ware is attained. A number of the ceramics have very high mechanical strength and compare favourably with some metals.

Electrical Properties

Ceramics insulation in use for electrical applications might be classified as low voltage and high voltage electrical porcelain, high frequency insulation (low dielectric loss), and high dielectric constant ceramics (capacitor dielectrics).

For most electrical applications high mechanical strength, good thermal endurance, and high dielectric strength are required. These and other requirements are fully met in the presently-available ceramics.

Abrasion Resistance

Dense, high-fired ceramics are hard and have high abrasion resistance. A few applications in which this property is used to advantage are grinding media and linings for mills, blasting nozzles, precision gauges, extrusion dies and thread guides.

Joining

The most common and widely-used means of attaching and joining ceramics in assemblies is by mechanical means. However, the recent trend is towards ceramic-to-metal seals.

As the physical size of the component is decreased, the stresses on the component parts necessarily are increased. Many electronic components require hermetic sealing. The present ceramic-to-metal seals can be divided into five general classes: matched seals, unmatched seals, soldered seals, brazed seals and mechanical seals.

Design Considerations

There are no definitely established limits on wall thickness. For practical purposes walls are held to a thickness which minimises ellipticity during firing of the part. This minimum thickness varies with the size of the part, the production method, and the type of ceramic.

The minimum thickness of flat plates or surfaces subject to warpage during firing depends on the method of production. In general, however, the minimum thickness should be ⅛ in., but it is better that it be ¼ in. or more. As the surface area increases, the minimum thickness, of course, also increases.

Ceramic parts produced by extrusion and subsequently machined can be held to a tolerance of ± 1 per cent. of the dimension involved. Parts manufactured by the wet press method have broader tolerances, ranging from 0·015 to 0·020 in. Often small, automatic press parts can be produced to a tolerance of ± 0·025 in.

In precision work requiring fine tolerances of ± 0·005 in., precision grinding is necessary, but is expensive.

HUNGARIAN TECHNICAL ABSTRACTS

THE effect of electrolytes on the strength of bentonite films, by A. Buzágh and E. Kugler. ("Magyar Kémikusok Lapja"—Journal of the Hungarian Chemical Society—Vol. IV, No. 8, pp. 466-472, August, 1949).

Strongly centrifuged suspensions of Transylvanian bentonite were poured on specially prepared surfaces; continuous, homogeneous and flexible films were obtained. The effect of various electrolytes on the strength of these films was studied. The examined electrolytes can be divided into two groups: 1. $NaCl$, Na_2SO_4, $MgCl$ and $AlCl_3$. 2. $NaOH$, Na_2CO_3 and Na_3PO_4. The strength of the film was influenced even by a slight concentration of electrolytes. Each of the curves showing the changes in the strength of the film has two maxima. In the first group of the tested electrolytes the first maximum was the higher. In the second group of electrolytes the second maximum was almost identical with the first or even slightly higher than the first maximum. The effect of electrolytes is correlated to the peptised, thyxotropic or coagulated condition of bentonite suspensions. Peptised suspensions provide bentonite films with the best mechanical properties: flexibility, elasticity and high strength. Films of thyxotropic gels were rigid and possessed less strength, continuous films could not be obtained from entirely coagulated suspensions. These changes can be explained by the actual changes in the cohesive forces between the bentonite particles.

Properties of bentonite-gels, by A. Buzágh. ("Magyar Kémiai Folyóirat"—Hungarian Journal of Chemistry—Vol. 56, No. 1, pp. 7-10, January, 1950).

Extensive investigations proved that bentonite is particularly suitable in colloidal chemistry as a model research material. The properties of bentonite are closely connected to the crystal structure of montmorillonite. The suspension of montmorillonite, respectively its sols behave as colloid electrolytes. The abnormities of stability of bentonite suspensions can also be explained by the crystal structure of montmorillonite. The changes occurring in suspensions of bentonite under the effect of $NaOH$ of increasing concentration are described in detail and the theoretical explanation of the phenomena is given.

The production of soft porcelain, by L. Mattyasovszky—Zsolnay. ("Építőanyag"—Building Materials—Vol. I, No. 5-6, pp. 23-25, May-June, 1949).

By way of introduction the author elucidates the notion of soft porcelain and gives a survey of its production in various countries. In Hungary, the output of hard-porcelain factories is insufficient to meet the present demands for china ware; for this reason we had to revert to the manufacture of soft porcelain. The undertaking is aided by the implemental facilities offered by a series of idle furnaces ready for immediate use. This method has, moreover, many outstanding features: reduction in the consumption of fuel, longer life of the muffles, and it scores another great advantage, i.e., that almost all the raw materials required can be supplied domestically.

A Hungarian china clay of unparalleled quality consisting of almost 100 per cent. illite lends itself most satisfactorily to the production of soft porcelain, and is available in inexhaustible quantities. The author, in dealing with the properties of illite, states that in spite of the difficulties arising in the initial stages of production, it will soon satisfy all requirements. In conclusion the author

comments on porcelain manufacturing methods as practised in other countries.

New types of cement, by E. Bereczky. ("Magyar Kémikusok Lapja"—Journal of the Hungarian Chemical Society —Vol. IV, No. 8, pp. 439-444, August, 1949).

Systematic research work on silicates was started in Hungary only after nationalisation. As a striking contrast to the former Hungarian system which utilised only a single type high-grade cement, the actual differentiation of the cement types is a measure of outstanding importance. The possibilities for use in industry of the various types of cement based on the development of cement chemistry and chemical composition are discussed in detail. Tricalcium silicate is the most valuable component of Portland cements; therefore it forms the basic material for alite-cement of Lábatlan which is now being tested. Decrease in the aluminate component leads to cement types resistant to the effects of sulphates, as for instance the Hungarian cement marked "S 54." The hydraulic factor also bears real influence on the strength (especially in respect to the initial strength) and heat generating properties of cement. The lime aluminate contents have a disadvantageous effect on shrinkage. Requirements of the cement consuming industries: 1. Cement of high initial strength for prefabricated parts. 2. High strength cement for bridge building. 3. Cement of fair average quality. 4. A cheap hydraulic binding agent for basements, masonry, etc. 5. Cement resistant to the effects of sulphates. The significance of "Sigma" cement and blast furnace cement is emphasised. The Hungarian cement industry lays the main stress on the m a n u f a c t u r e of heterogeneous cements.

A GREAT MAN PASSES

SIR FRANCIS JOSEPH was a great man not only for his achievements in business, but because of his almost insatiable interest in people and their activities. In his passing his many friends in North Staffordshire will mourn. He left by words and deeds sufficient for his remembrance—only a month or so ago he spoke to the members of the British Pottery Managers' Research Association on his visit to America; then it was he said:

Meet the People

"One of England's most vital needs at the moment is for a more personal knowledge of the people of the United States. One thing is certain; the oftener we meet one another the better it will be for ourselves and the world. We must always bear in mind that inventions in marine engineering have narrowed the distance which separates our two nations, whilst the progressive science of aviation has done much to make us nearer neighbours and firmer friends.

Titanic Task

"Two world wars have united us in spirit. Common ideals have joined us together to preach peace on earth and goodwill to all mankind. Each nation needs the other. Business worries often lead to political misunderstanding but let us never forget that the other's point of view may be sometimes right. Differences cannot always be cleared up by correspondence. It is personal contact which removes friction. That is the best lubricant. The commercial traveller oftentimes does more good in solving problems between nations than statesmen or official delegations. The business man supplies the oil which makes the wheels go round.

"This proves how great is the debt we owe to the younger generation of the potters of North Staffordshire and the men of Birmingham and the Midlands in the motor and engineering industries who have blazed the trail from East to West of the U.S.A. and created such an increased demand for British goods by reason of quality, design and value that the dollar gap is vanishing like morning mists. Britain's example and efforts since the war have won the respect of the American continent. The U.S.A. accepts our effort as inconvertible proof that we will only accept help until we have repaired the ravages of war. We know it has been a titanic task and yet

to be completed, but once again it demonstrates the truth of Pitt's arresting phrase 'We have saved England by our exertions and the world by our example'."

How right indeed! To repeat "The commercial traveller oftentimes does more good in solving problems between nations than statesmen or official delegations." How true. But how sadly overlooked by 20th Century political bigotry.

HARDINGE CONSTANT WEIGHT FEEDER

AS a feeder for ball, tube and rod mills for dryers, kilns, etc., and as a proportioning device where two or more feeders deliver to a common point for mixing ingredients in uniform quantities, this constant weight feeder has claimed advantages over the volumetric type.

With the normal volumetric type of belt feeder which has a fixed frame and gate opening, the weight of material delivered by the feeder varies directly according to any changes which may take place in the specific gravity of the material.

The Hardinge feeder, however, has a pivoted frame which takes up various angular positions according to the weight of material on the belt. The position, therefore, and consequent gate opening (actuated through links from the frame) is effected by the specific gravity of the material. A change in weight of material on the belt causes the gate to open or close, thereby causing more or less material to be delivered, depending on the change in specific gravity of the material on the belt. The operation of the machine is shown in Fig. 1.

A mercury switch is fitted under the belt to ensure that the feeder only operates when material is on the belt, thus if the bunker runs empty or the material "arches over," the feeder automatically stops.

The total tonnage delivered can be computed by means of the revolution counter, fitted to the belt pulley. In order to arrive at the quantity delivered, it is necessary to bypass the feeder discharge into a container over a definite period

OVERALL WIDTH OF FRAME C

BELT WIDTH A

OVERALL WIDTH OF COMPLETE MACHINE H
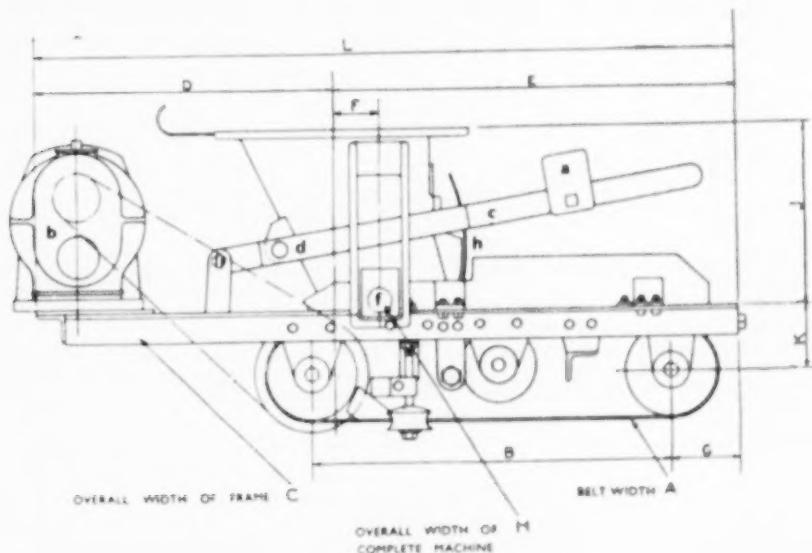
Type C. Hardinge constant weight feeder

APPOINTMENTS VACANT

THE Council of Scientific and Industrial Research, India, invites applications for a post of Assistant Director (Ceramics) in the Central Glass and Ceramic Institute, Calcutta.

Candidates should possess M.Sc. in Ceramics or higher degree in an allied subject and ten years' experience in pottery and porcelain in a research, teaching or technical institution including at least three years in a responsible position in a pottery works.

Contract for 5 years. Salary in scale Rs. 600-1,500 a month (rupee = 1s. 6d.) plus dearness and other allowances as sanctioned by Government. Higher initial salary to exceptionally qualified candidate. Provident Fund. Free passage.

Applications in duplicate stating age, qualifications, experience, etc., with copies of testimonials and published papers should reach the Secretary, Council of Scientific and Industrial Research, "P" Block, Raisina Road, New Delhi, by 24th March, 1951.

Supplementary information from High Commission of India, General Department (D), Aldwych, London, W.C.2.

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and, at the same time, noting the number of revolutions made by the belt pulley. It will be readily seen that the total tonnage can be computed over a given period.

Three sizes of feeder are made and they are suitable for handling materials in granular form such as stone, ore, coal, etc. The largest machine will handle a maximum of approximately 70 to 80 tons per hour of stone, having a bulk density of 85 lb./c. ft. The capacity varies with different materials; light materials would be less—heavy materials more.

and reduction gear. When material drawn from the hopper changes in weight per c. ft. due to change in size, bulking effect and specific gravity of the material, the frame carrying the belt commences to tilt. If the material increases in weight per c. ft. the belt tilts down. This raises lever (c) and partially rotates it about pivot (d) which in turn lowers gate (h). This decreases the volume of material drawn from the hopper and brings the frame back to equilibrium, thus compensating automatically the amount of material discharged from the hopper. To change the amount of

Size of feeder	A	B	C	D	E	F	G	H	J	K	L
	in.	in.	in.	in	in.	in.	in.	in.	in.	in.	in.
A	8	20¼	14¼	14½	21¼	1¼	4½	17	9¾	4	36
B	12	24	19½	19¼	27½	2¼	4½	25¼	11	4¼	47¼
C	26	24	33¼	20	27	3	4½	39¼	13	4¼	47

The principle of operation, is as follows (Fig. 1):
A short conveyor belt is mounted on a movable frame and suspended from pivot (f). Counterbalance weight (a) equalises the weight of material as drawn from the hopper belt, driven by motor (b)

material discharged from the hopper, the weight (a) is moved towards the pivot for greater capacity and away from the pivot for less capacity.

Further details are available from International Combustion Ltd., 19 Woburn Place, London, W.C.1.

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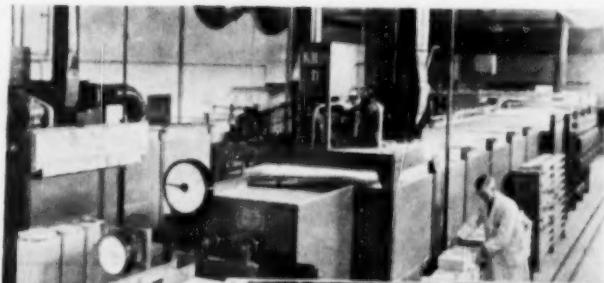
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